COMMONWEALTH INST. ENTOM. LIBRARY
27 AUG 1949
U.S.D.A. 146
SERIAL SEPARATE

Mosquito News

Published Quarterly
by the
AMERICAN MOSQUITO CONTROL ASSOCIATION

VOLUME 9 JUNE, 1949 NUMBER 2

CONTENTS

ARTICLES PAGE

Mosquitoes and Mosquito Control in Canada ..... C. R. Twinn 35
Prehatching Treatments for the Control of *Aedes* in Alaska
B. V. Travis, C. M. Gjullin, F. S. Blanton, Nelson Smith and C. S. Wilson 42
A Method for Artificially Feeding Mosquitoes ..... Joseph Greenberg 48
The Effectiveness of Prehatching Treatments for the Control of Arctic Mosquitoes
Wm. C. McDuffie, J. F. Sharp, H. F. Cross, C. R. Twinn and W. M. Wilson 51
Anopheles gambiae melas Control by Swamp Drainage in a Coastal Zone of Nigeria, British West Africa ..... Leonard J. Chwatt 56
Observations on the Use of Toxic Briquettes for Mosquito Control .. T. G. Raley and E. D. Davis 68
A Note on Disease-Bearing Mosquitoes Breeding in Bromeliads ..... W. H. W. Komp 72

NEWS AND NOTES 73

ASSOCIATION NEWS
The 1949 AMCA Meetings in California 78
Second Report of the AMCA Good Neighbor Club ..... H. H. Stage 78

EDITORIAL SECTION
The Psychological Effect of DDT in the Mosquito Control Program ..... Luis Vargas 80

REVIEWS AND ABSTRACTS
The Place of DDT as an Anopheline Larvicide. By G. Macdonald ..... Helen Sollers 81
A Preliminary Evaluation of Some Insecticides Against Immature Stages of Blackflies (Diptera: Simuliidae). By B. Hocking, C. R. Twinn and Wm. C. McDuffie
C. C. Deonier 81
The Pupae of the Mosquitoes of New Guinea. By G. H. Penn ..... H. R. Dodge 81
Chronicle of the World Health Organization ..... H. L. T. 82
The Mosquitoes of Bwamba County, Uganda. VI. By A. J. Haddow ..... W. H. W. Komp 82
Combate Especifico Ao Vetor de Malaria Em Zona de Transmissao por Anofelinos Do Sub-Genero "Kerteszia." By Maria O. Ferreira ..... W. H. W. Komp 82
Mosquito Control at Rosemere ..... R. L. Armstrong 82
Proceedings of the 4th International Congresses on Tropical Diseases and Malaria
F. C. Bishopp 83
Species Eradication. The Eradication of *Anopheles gambiae* from Upper Egypt 1942–1945. By Sir Aly Tewfik Shousha ..... A. B. Weathersby 83
A Preliminary Account of the Biting Flies at Churchill, Manitoba. By C. R. Twinn, B. Hocking, W. C. McDuffie and H. F. Cross ..... Don M. Rees 84
Reports from Mosquito Control Districts ..... H. L. T. 84

GENERAL BIBLIOGRAPHY 86

LIST OF ADVERTISERS 92

ADVERTISING RATES 41

MOSQUITO NEWS

Official Publication of the American Mosquito Control Association

PUBLICATIONS COMMITTEE

R. D. Glasgow, Chairman, Albany, N. Y.
C. T. Williamson, Yaphank, N. Y.
T. D. Mulhern, New Brunswick, N. J.
H. D. Peters, Jacksonville, Fla.
Archie D. Hess, Wilson Dam, Ala.
Bernard V. Travis, Orlando, Fla.

Editorial Office, State Education Building, Albany, N. Y.

R. D. Glasgow, Consulting Editor D. L. Collins, Acting Editor

Margaret G. Slater, Editorial Assistant

Associate Editors

H. H. Stage (Current Bibliography—"References to Literature of Interest to Mosquito Control Workers"), Washington, D. C.

Helen L. Trembley (Reviews and Abstracts), National Institute of Health, Bethesda 14, Md.

Richard F. Peters, Berkeley 1, Calif.

R. L. Vannote, Advertising Manager, Morristown, N. J.

C. T. Williamson, Business Manager, Yaphank, N. Y.

T. D. Mulhern, Secretary and Treasurer of the Association, New Brunswick, N. J.

Published by

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

Printed by

Boyd Printing Company, Inc., Albany, N. Y.

A quarterly journal published on the 20th of March, June, September and December. Devoted to the improvement and the sound extension of mosquito control and related work as a vital public service.

SUBSCRIPTION RATES

$4.00 per Year (U. S. money), Single Copies, $1.00
Mailed without charge to members of the Association.

MEMBERSHIP DUES

Associate Members $4.00
Active Members 5.00

BUSINESS COMMUNICATIONS

Communications relating to editorial matters and manuscripts submitted for publication in Mosquito News should be addressed to Donald L. Collins, Acting Editor, Mosquito News, New York State Musuem, Albany, New York.

Communications relating to advertising space should be addressed to R. L. Vannote, Advertising Manager, Mosquito News, 3 Franklin Place, Morristown, New Jersey.

Communications relating to subscriptions to Mosquito News, Membership in the American Mosquito Control Association, and other association matters should be addressed to Thomas D. Mulhern, Secretary-Treasurer, American Mosquito Control Association, New Brunswick, New Jersey.

Copyright 1949 by

The American Mosquito Control Association

ARTICLES

MOSQUITOES AND MOSQUITO CONTROL IN CANADA *

C. R. TWINN
Ottawa, Ont.

In the vast Canadian territory extending from the Atlantic to the Pacific, and from the International Boundary to the Arctic, 59 species of mosquitoes belonging to 8 genera have been recorded. These include 39 species of *Aedes;* 5 species each of *Anopheles, Culex* and *Culiseta;* 2 species of *Psorophora,* and 1 species each of *Mansonia, Wyeomyia* and *Uranotaenia.* A summary of the recorded distribution of these species by provinces and territories is given in Tables 1 and 2.

The species of *Psorophora, Wyeomyia* and *Uranotaenia* have no significance as pests in Canada. Species of *Culex, Culiseta, Mansonia* and *Anopheles* are locally and seasonally troublesome in various parts of the Dominion. But the really important pests are the widespread and dominant transient water breeders, the *Aedes.* The species of this genus are well adapted to thrive and multiply in our northern clime. The long rigorous winter is passed in the egg stage on the ground beneath the ice and snow in low-lying places subject to flooding in the spring. For most of the species, exposure of the eggs to winter cold appears to be a prerequisite to hatching. Melting snow, rain and river floods produce the extensive temporary bodies of water that form a favorable environment for the teeming larvae.

In general, the greatest emergence of *Aedes* mosquitoes takes place in the spring. The insects may persist for several weeks, but their numbers usually diminish as mid-summer approaches. Because spring comes earlier the peak of abundance is reached earlier in southern Canada than farther north in the sub-arctic forest or beyond the tree line. For instance, in the Ottawa region, mosquitoes are usually most troublesome in late May and June, whereas at Churchill, on Hudson Bay, the period is late June and July.

Although certain species are suspected of being implicated in the transmission of human and equine encephalomyelitis, mosquitoes are relatively unimportant as disease carriers in Canada. There is no question, however, as to their importance as pests. A majority of the species, and especially the *Aedes,* are avid bloodsuckers and often cause great annoyance and discomfort to man and beast. To some extent their presence may locally reduce land values, interfere with farming and lumbering operations and other outdoor employment, reduce the productivity of livestock and poultry and impede recreational activities.

So far, however, mosquito control has not been practised on a large scale in Canada, and probably not more than two dozen communities carry out regular, organized control efforts annually, and the expenditures involved usually are very modest. One reason for this may be that in most settled areas, mosquitoes are rarely very troublesome for periods longer than a few weeks. In many communities where they may sometimes be very annoying for short periods in spring or summer, severe and prolonged outbreaks occur too seldom to arouse the public sufficiently to bring about the establishment of control arrangements on a properly organized and permanent basis.

For many years (1926–1941) Dr. Arthur Gibson, formerly Dominion Entomologist, gave a yearly account of mosquito suppres-

* Contribution No. 2587, Division of Entomology. Science Service, Department of Agriculture, Ottawa, Ontario.

TABLE I

DISTRIBUTION BY PROVINCES OF MOSQUITO SPECIES IN CANADA

- THE GENUS AEDES -

PROVINCE	aboriginis Dyar	atropalpus Coq.	aurifer Coq.	campestris D. & K.	canadensis Theo.	cantator Coq.	cataphylla Dyar	cinereus Mgn.	communis Deg.	cyclocerculus Dyar	diantaeus H.D. & K.	dorsalis Mgn.	excrucians Wlk.	fitchii F. & Y.	flavescens Müll.	idahoensis Theo.	impiger Wlk.	implacabilis Wlk.	increpitus Dyar	intrudens Dyar	lateralis Mgn.	leuconotips Dyar	nearcticus Dyar	nigripes Zett.	nigromaculis Ludl.	pacificensis Hearle	pionips Dyar	pullatus Coq.	punctor Kby.	riparius D. & K.	sollicitans Wlk.	spencerii Theo.	sticticus Mgn.	stimulans Wlk.	trichurus Dyar	triseriatus Say	trivittatus Coq.	varipalpus Coq.	vexans Mgn.
Prince Edward Island						▲		▲	▲			·	▲	▲													▲							▲				▲
Nova Scotia					▲	▲		▲	▲		▲		▲					▲		▲									▲				▲	▲	▲	▲		▲
New Brunswick					▲	▲			▲											▲										▲		▲		▲	▲			▲
Quebec			▲	▲	▲			▲	▲		▲	▲	▲	▲						▲			▲	▲			▲	▲	▲				▲	▲	▲		▲
Ontario		▲	▲		▲			▲	▲		▲	▲	▲	▲				▲		▲				▲			▲	▲	▲			▲	▲	▲	▲		▲
Manitoba			▲	▲	▲			▲	▲				▲	▲	▲		▲			▲				▲	▲			▲	▲			▲	▲	▲			▲
Saskatchewan	▲			▲	▲			▲	▲			▲	▲	▲	▲		▲		▲	▲	▲			▲				▲	▲			▲	▲				▲
Alberta				▲	▲		▲	▲	▲			▲	▲	▲	▲		▲		▲	▲			▲	▲			▲	▲	▲		▲	▲	▲				▲
British Columbia	▲			▲	▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		▲	▲	▲	▲		▲		▲	▲	▲	▲		▲	▲	▲	▲	▲	▲	▲
Yukon				▲	▲		▲	▲	▲				▲	▲			▲						▲				▲	▲				▲	▲				▲
Northwest Territories									▲				▲	▲										▲	▲		▲	▲									

TABLE 2

DISTRIBUTION BY PROVINCES OF MOSQUITO SPECIES IN CANADA
– GENERA OTHER THAN AEDES –

PROVINCE	ANOPHELES					CULEX					CULISETA					OTHER GENERA				
	freeborni Aitken	occidentalis D. & K.	punctipennis Say	quadrimaculatus Say	walkeri Theo.	apicalis Adams	pipiens L.	restuans Theo.	salinarius Coq.	tarsalis Coq.	alaskaensis Ludl.	impatiens Wlk.	incidens Thom.	inornata Will.	morsitans Theo.	Psorophora ciliata Fab.	Psorophora ferox Humb.	Mansonia perturbans Wlk.	Uranotaenia sapphirina O.S.	Wyeomyia smithii Coq.
Prince Edward Island																		▲		
Nova Scotia		▲	▲		▲	▲	▲		▲						▲			▲		▲
New Brunswick		▲	▲		▲	▲	▲	▲				▲			▲					
Quebec		▲	▲	▲	▲	▲	▲	▲							▲	▲		▲	▲	
Ontario		▲	▲	▲	▲	▲	▲	▲				▲		▲	▲	▲	▲	▲	▲	▲
Manitoba		▲	▲		▲	▲	▲	▲		▲	▲	▲		▲	▲			▲		▲
Saskatchewan		▲				▲		▲		▲	▲			▲	▲					
Alberta		▲								▲	▲	▲	▲	▲	▲					
British Columbia	▲	▲	▲		▲	▲	▲			▲	▲	▲	▲	▲	▲			▲		
Yukon		▲									▲	▲	▲		▲					
Northwest Territories												▲								

sion work in Canada before the annual meetings of the New Jersey Mosquito Extermination Association, in Atlantic City. These statements were published in the Proceedings of the Association. More or less routine control work is still being continued at most of the centres referred to in Dr. Gibson's reports.

This presentation deals briefly with some of the more important mosquito problems in Canada as a whole. Those problems naturally vary greatly in different parts of the country depending on topography, vegetation, climate, prevailing species, and so on. Certain species are characteristic of particular kinds of habitats and it may be convenient, if somewhat arbitrary, to discuss them according to such general groupings as floodwater, forest, salt marsh, prairie and arctic mosquitoes.

FLOODWATER MOSQUITOES

The flooding of low areas in spring and early summer by rivers swollen by melting snow and heavy rains is the cause of periodic outbreaks of certain species of mosquitoes. In wooded river valley bottoms the most important of these is *A. lateralis* Mgn., in British Columbia, and *A. sticticus* Mgn., in the more eastern provinces. Other species also occur in the floodwaters, but usually they represent only a small proportion of the infestation.

The Ottawa River Valley provides a

good example of an area in Eastern Canada that is periodically subjected to outbreaks of *A. sticticus* in spring and early summer. The occurrence and extent of these outbreaks is entirely dependent on the level attained by the Ottawa River at freshet time. At Ottawa, for instance, little or no flooding occurs when the river fails to rise higher than 140 feet above sea level. Between 140 and 144 feet extensive flooding of low-lying areas north of the city takes place, and from these areas enormous numbers of mosquitoes may emerge, if not controlled, and migrate distances up to four miles into Ottawa and neighboring municipalities. When the river level goes much above 144 feet, however, river and flooded areas are likely to become directly connected and, when this happens, much of the larval infestation may be swept away and destroyed.

Until 20-odd years ago these outbreaks were endured without effective action being taken. Then, following a careful study of the problem, the Division of Entomology gave leadership in a successful control demonstration carried on for the three years: 1927, 1928 and 1929. For many years now the Ottawa Federal District Commission has had the responsibility of combating the pests and has given the residents of the district a large measure of protection from these intermittent outbreaks.

In British Columbia, *A. lateralis* is the dominant pest species in flooded wooded bottom lands in river valleys such as the Fraser and Thompson. In flooded meadows and other open places *A. vexans* Mgn. usually predominates. These floods result from the rivers overflowing their banks at freshet time, and the severity of the infestation depends on the extent and duration of the floods. Mosquito conditions in the Lower Fraser Valley have been well described by Hearle (1). Control has been practiced on a modest scale for many years in a number of municipalities in the river valleys affected by these and other species of mosquitoes.

Unusually severe floods occurred in British Columbia in the spring of 1948, causing extensive loss and damage to property. The floods also rather belatedly raised fears of the possibility of a tremendous outbreak of mosquitoes developing in the Lower Fraser Valley and adding to the general woe. The Provincial authorities thereupon engaged the services of a commercial pest control organization to combat the potential nuisance. Large areas were treated by aircraft and ground equipment, using DDT in oil solution, as an emulsion, and in dust form. The work was organized on very short notice and carried out largely by inexperienced personnel, to some extent using formulations that did not take proper advantage of the effectiveness and economy of DDT. For instance, very low concentrations would be used requiring the application of large quantities of larvicide per acre to attain a lethal dose.

Actually, there was some question as to the effectiveness of the control work, as it was started too late to destroy the bulk of the infestation before emergence. However, Mr. Colin Curtis, of the Dominion Livestock Insects Laboratory, Kamloops, B. C., who observed and reported on the operations and their results, noted that the general infestation of mosquitoes was light, a condition which may largely have been brought about by the height and extent of the flood, the current sweeping away the larvae to destruction in the river.

FOREST AND WOODLAND MOSQUITOES

Forest and scattered woodlands cover a large part of Canada south of the region where the ground is permanently frozen. A number of typical forest-loving species of *Aedes* inhabit the northern woods and have a widespread distribution. Included among these are *A. punctor* Kby., *A. communis* DeG., *A. impiger* Wlk., *A. intrudens* Dyar, *A. cinereus* Mgn., and *A. canadensis* Theo. More localized in distribution are *A. pionips* Dyar, *A. diantaeus* H.D. & K., and *A. cataphylla* Dyar. Although often a severe pest to animals and man in the forest, most of

these species rarely appear to be troublesome in open country, but may venture short distances from the shelter of woods after sunset and at other times when conditions are favorable.

Other widely distributed and important pest species that favor wooded areas, but attack freely in the open as well as in the shelter of trees are *A. stimulans* Wlk., *A. fitchii* F. & Y., *A. excrucians* Wlk., and *A. trichurus* Dyar. The larvae of these species are frequently found associated together in temporary pools in spring. *A. trichurus* is one of the earliest *Aedes* mosquitoes to appear on the wing.

The mosquitoes in the forest are of particular concern to the lumbering and mining industries and to all those who live in or have occasion to visit the woods. Where control is required in specific areas aerial spraying directed against the larvae or adults, or both, and applied after a suitable survey, is probably the most economical and effective method of combating them. Usually, the absence or scarcity of suitable roads and the nature of the terrain render difficult or impossible the satisfactory use of ground equipment, except on a very limited scale. On the other hand, the natural barrier provided by dense forest, and the usually limited flight range of the common forest species, should greatly enhance the effectiveness of area control as compared with similar treatment applied in more open country. Where control is not a practicable proposition, individuals must protect themselves by wearing suitable clothing, using repellents and providing fly-proof shelter for sleeping and relaxation.

SALT MARSH MOSQUITOES

It is doubtful that mosquitoes in this category anywhere in Canada ever attain the status as pests of the famed salt marsh mosquitoes of New Jersey. However, *A. sollicitans* Wlk., and *A. cantator* Coq., are locally troublesome in coastal regions of the Maritime Provinces, and in some seasons and in some places may become very numerous.

The towns of Amherst, N. S., and Moncton and Sackville, N. B., are greatly bothered by mosquitoes from the neighboring Tantramar marshes. These extend over more than 100 square miles and contain both brackish and fresh water areas which give rise to immense numbers of *A. cantator* and *A. vexans* when conditions are favorable. The extensive dykes that protect the area from the sea and the ditches that are supposed to drain the marshes have long suffered from neglect. Palliative measures such as applying larvicides to the breeding places near the towns are likely to give but indifferent results, because of the great extent of the infested area and the flight range of the marsh species. The problem probably can only be solved satisfactorily by a program of reclaiming the whole dykeland. This would not only deal with the mosquito pest, but would also greatly increase the agricultural value of the land.

In Pacific Coast areas the locally troublesome species breeding in tidal pools and salt marshes is *A. dorsalis* Mgn., which is an adaptable species with a wide distribution eastward across the Prairie Provinces into Eastern Canada.

PRAIRIE MOSQUITOES

On the open prairies of Manitoba, Saskatchewan and Alberta the four most common species are *A. spencerii* Theo., *A. flavescens* Müll., *A. campestris* D. & K., and *A. dorsalis*. The latter two, and *A. idahoensis* Theo., which is closely related to *A. spencerii*, are also very common in the open grasslands of the interior of British Columbia. All of them breed in temporary snow and rain pools and are abundant or scarce depending on the amount of surface water and prevailing weather conditions. In addition to the typical prairies, several of these species occur farther north in patches of grassland in the forest and on tundra-meadow near the tree line as observed at Churchill. Another species which is a widespread pest on the prairies in wet seasons is *A. vexans*. The latter is not confined to the prairies,

but occurs across Canada, favoring breeding places in the open, but not avoiding woods. All of these species appear to have migratory tendencies. Other species which are sometimes troublesome in the prairie region are *A. riparius* D. & K., *A. excrucians* and *A. fitchii,* which favor areas where poplars grow.

Control on a fairly large scale has been practised annually in the Winnipeg area for more than 20 years. The intensity and extent of the infestation that has to be combated varies from season to season depending on snowfall and spring and summer rains. A brief history of these control efforts was published by Dr. H. M. Speechly (4) in 1947.

The main pest species affecting Winnipeg are *A. spencerii* and *A. vexans.* When conditions such as a wet season favor the widespread abundance of these pests on the prairies, control in any restricted area is difficult because the insects invade the area from the surrounding countryside.

Saskatoon, Saskatchewan, is another prairie city where control is attempted from year to year. This largely takes the form of systematic oiling of the sloughs and temporary pools within a radius of three to five miles from the centre of the city. These modest efforts have been reported to give a considerable measure of relief even when heavy infestations were general outside the treated area.

Mosquito abundance on the prairies is largely regulated by the amount of snowfall and spring and summer rains, and in seasons of deficient precipitation when surface water is at a minimum there is likely to be little trouble from mosquitoes. As pointed out by Hearle (2) "plough and harrow have levelled low places and cultivation has made the soil porous," so that even in wet seasons mosquitoes are not nearly so serious a pest on the prairies as they were in early pioneer days.

ARCTIC MOSQUITOES

Generally speaking, the number of species of mosquitoes diminishes as one goes northward. For example, in the vicinity of Ottawa, in the Ottawa Valley, 28 species belonging to 7 genera have been recorded. These include 4 species of *Anopheles,* 17 species of *Aedes,* 3 species of *Culex,* and 1 species each of *Culiseta, Mansonia, Wyeomyia* and *Uranotaenia.* In the vicinity of Churchill on Hudson Bay, about 1200 miles (as the plane flies) northwest by north of Ottawa, where swampy, sub-arctic coniferous forest gives way to treeless tundra, 12 species of only 2 genera of Culicinae have been identified, including 10 species of *Aedes* and 2 of *Culiseta.* On the arctic tundra at Baker Lake, N.W.T., about 400 miles due north of Churchill only 3 species of one genus *(Aedes)* have been found.* These are *A. nigripes* Zett., *A. nearcticus* Dyar, and a form closely resembling, if not identical with *A. punctor* Kby., a forest species of wide distribution farther south. During 1948, several small survey parties working under the direction of the Division of Entomology collected and reared biting flies and other insects at various points in the arctic, but the results from this work have not yet been fully evaluated. Studies so far indicate that *A. nigripes* and *A. nearcticus* are widespread in arctic and sub-arctic Canada, and are dominant pests on the tundra, or so-called barren lands.

Although species are few in the Far North this is often more than compensated for by their extraordinary numbers. An important factor contributing to this abundance is doubtless the permanently frozen condition of the ground beneath the surface, which results in poor drainage in spring and summer, and the formation of innumerable shallow pools which serve as mosquito breeding places. When weather conditions favor mosquito activity the insects may attack their hosts both day and night, and, in areas of heavy infestation, by their incessant attempts to obtain blood may make life difficult even for the most hardy individuals, properly dressed and equipped with head nets and repellents though they may be. An

* Coll. by Dr. T. N. Freeman, July-Aug. 1947.

interesting review of the rather horrendous accounts by various travellers and explorers of the abundance and ferocity of the mosquitoes in arctic regions is included in Natvig's (3) recently published book on the Danish and Fennoscandian mosquitoes.

These mosquitoes of the tundra are strong fliers and, like the prairie species to the south, appear to migrate freely, no doubt often aided by the wind. This matter of the flight or migration range of mosquitoes, particularly the species inhabiting treeless areas, is of great importance in relation to the planning and carrying out of control measures, but unfortunately it is a subject about which there is still little exact information.

It may be of interest to mention that a study of the biology and control of mosquitoes and other species of biting flies in the north was incepted at Churchill, Manitoba, on the western shore of Hudson Bay, in the early spring of 1947, and continued during 1948. This was a joint project of the Division of Entomology, on behalf of the Canadian Defense Research Board, and the U. S. Bureau of Entomology and Plant Quarantine, on behalf of the Surgeon General, Dept. of the U. S. Army. A preliminary report of the results of the biological studies has been published by Twinn *et al.* (5) and papers on other aspects of the work are under preparation or in press.

References

1. HEARLE, E. The mosquitoes of the Lower Fraser Valley, British Columbia, and their control. N.R.C. Ottawa, Can., Rpt. No. 17, 94 pp., illus., 1926.
2. HEARLE, E. The life-history of *Aedes flavescens Müll.* Trans. Roy. Soc. Canada, 23:85–102, 1929.
3. NATVIG, LEIF R. Contributions to the knowledge of the Danish and Fennoscandian mosquitoes. Culicini. Norsk Entomologisk Forening. Suppl. 1 567 pages, 148 figs., 41 tables, 12 plates, 1 map. Oslo: A. W. Broggers Boktrykkeri A/S, 1948.
4. SPEECHLY, H. M. Twenty years of mosquito control in and around Winnipeg, Canada, 1927–1946. Proc. 34th Ann. Meet. N. J. Mosq. Ext. Assoc. pp. 98–101, 1947.
5. TWINN, C. R., B. HOCKING, WM. C. MCDUFFIE AND H. F. CROSS. A preliminary account of the biting flies at Churchill, Manitoba. Can. Jour. of Res. Vol. 26, Sec. D, Dec. 1948.

ADVERTISING RATES
FOR
Mosquito News

	1 issue	4 issues
Full-Page	$40.00	$144.00
Half-Page	$24.00	$86.40
Quarter-Page	$16.00	$57.60

Preferential Positions — $5.00 an issue extra
1. Facing Front Cover 2. Facing First Article
3. Facing Back Cover

For Information Write
ROBERT L. VANNOTE
Advertising Manager,
3 Franklin Place, Morris Plains, N. J.

PREHATCHING TREATMENTS FOR THE CONTROL OF *AEDES* IN ALASKA [1]

B. V. TRAVIS,[2] C. M. GJULLIN,[2] F. S. BLANTON,[3] NELSON SMITH,[2] AND C. S. WILSON,[4, 5]

A recent approach to the control of marsh-breeding mosquitoes has been the application of insecticides to breeding areas before the eggs hatch. The unusual stability of the new insecticides permits their application several weeks or months in advance of the mosquito-breeding season. This method, now known as the preflooding or prehatching treatment, may prove a useful adjunct to other control measures.

Favorable results with prehatching treatments of DDT have been reported against *Psorophora* in Florida (Wisecup and Deonier 1945) and in Arkansas (Wisecup *et al.* 1945, Horsfall 1946). Poor control of the salt-marsh mosquitoes *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Walk.) was obtained in Florida with light applications of DDT (Wisecup *et al.* 1947), but good control of those species was obtained with heavy applications (Deonier *et al.* 1948). This method was also found effective against floodwater *Aedes* along the Columbia River in Oregon (Yates and Gjullin 1947). In New Jersey promising results against fresh-water swamp mosquitoes were obtained with DDT but not with benzene hexachloride (Hansens and Hart 1947). Perhaps the most effective use of prehatching treatments is indicated by applications to snow for *Aedes* control in Washington (Roth *et al.* 1947, Lindquist *et al.* 1948) and near Churchill, Canada (McDuffie *et al.* 1949). This paper will describe tests on a large series of plots in Alaska treated during the fall of 1947 and the spring of 1948.

Materials and Methods.—A total of 201 one-fourth and one-half acre plots were treated with rotary hand dusters and 3-gallon cylindrical pressure sprayers. Forty 5 to 10-acre plots were treated with either an L-5 or a UC-64 (Norseman) airplane.

The plots treated with hand equipment were in the vicinity of Anchorage, Gulkana, Tok, Tanacross, and Paxton, Alaska. Four or five replications were made of each treatment, one in each of several different mosquito-breeding environments —natural depressions and old roadways where sedge (*Carex*) was the predominant vegetation, and bogs with plant associations of *Myrica* (*M. gale*)-heath-*Sphagnum, Sphagnum*-heath, and *Sphagnum*-sedge-heath. The plots treated by airplane were in the following plant associations: deep grassy (*Calamagrostis canadensis*) depressions, *Sphagnum*-heath, *Sphagnum-Myrica*-birch (*Betula nana*) and *Sphagnum*-heath-sedge. These test areas were hummocky with accumulations of water between the hummocks, and all were known mosquito producers.

Half the plots were sprayed in August 1947. At this season there was little or no water in bogs having sedge or grass as the predominant vegetation, whereas in the other environments most of the depressions between the hummocks were filled with water. The remainder of the plots of each type were treated in March and April 1948, when the snow was 3 to 30 inches deep.

In the plots treated by hand DDT was applied in emulsions, fuel-oil solutions, dusts, and wettable powders. Chlordane,

[1] This work was conducted under funds allotted by the National Military Establishment to the Bureau of Entomology and Plant Quarantine.

[2] U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine.

[3] Lieutenant colonel, MSC, U. S. Army.

[4] Entomologist, Army Engineers.

[5] The authors wish to express their appreciation to other members of the staff who assisted in treating and checking the plots.

toxaphene, methoxychlor, TDE, and parathion were applied in fuel-oil solutions. Benzene hexachloride (12 per cent gamma) was applied both in fuel-oil solutions and in 50 per cent wettable powders. To each 5 gallons of fuel oil 1 quart of cyclohexanone was added to insure stable solutions during cool weather, and also, in the spring, 1 pint of alcohol to prevent moisture in the cans from freezing and stopping the spray nozzles. The dusts were diluted with pyrophyllite. All liquids were applied at the rate of 2.5 gallons per acre. The dusts were applied at 5 pounds per acre except for benzene hexachloride, which was applied at the rate of 8.4 pounds of dust per acre.

The airplane plots were treated with a 20 per cent DDT concentrate diluted with fuel oil to obtain different dosages. From 2 to 8 quarts of spray per acre were applied in the fall and from 1 to 2 pints in the spring. Red dye was added to the sprays, and white cards were placed at 25-foot intervals across the plots to determine whether the spray was well distributed.

All plots were dipped from 2 to 6 times to determine the effect of the various treatments. In most tests from 30 to 60 dips per plot were made at each observation in the hand-treated plots and from 30 to 100 in the airplane plots. A total of 22,823 dips were made in the hand-treated plots and 13,981 in the airplane plots.

Although the numbers of larvae taken during the preliminary observations are reported, the per cent control is based on the final observation and includes both larvae and pupae.

Results. *Hand-treated Plots.*—The data for the hand-treated plots, as summarized in table 1, are averages for all plots given the same treatment. Complete control was obtained only with DDT applied at the rate of 2 pounds per acre as an emulsion. A 90 per cent or higher control was shown in plots treated with DDT in the fall at the following rates per acre: 2 pounds in fuel-oil solution, emulsion, and wettable powder; 0.5 pound in fuel oil and wettable powder; and 0.1 pound in an emulsion. Of the spring treatments, only the 0.1 pound dosage of DDT in fuel oil and the 0.5 pound dosage of TDE gave more than 90 per cent control. The following applications gave 70 to 89 per cent control: Fall applications of DDT at 1 and 0.1 pound in fuel oil, 1 and 0.5 pound in emulsions, 2 pounds in dust, and of benzene hexachloride wettable powder at 0.5 pound of the gamma isomer; spring applications of 0.5 pound of DDT in fuel oil and in emulsion. All other treatments gave less than 70 per cent control. Parathion and methoxychlor were ineffective as prehatching treatments.

It was observed during the dipping that newly hatched larvae were being killed by some of the treatments. This observation is confirmed by the low counts in the preliminary observations of plots in which the treatments were effective. During the early observations it was common to find only first-instar larvae in treated plots, whereas in untreated plots other instars were present.

There was little evidence of a delayed kill. Dead larvae were rarely seen in the treated plots. In 16 of the 39 treatments the larval population was not significantly lower at the final observation than during the preliminary observations. In the remaining treatments the final observation showed higher populations.

In a number of plots receiving various DDT treatments no larvae were taken during the entire study period. The effectiveness of treatments in these plots was confirmed by the death of larvae that were transferred to pools in these plots. Conversely, introduced larvae survived in plots where the insecticides appeared noneffective.

The degree of variation in populations in these studies is illustrated in table 2, which gives data for the moss-heath plots treated with DDT-fuel oil solutions. All the variations may not be due to the chemical, as similar variations are noted in the check plots. It is evident, however,

TABLE 1. Effectiveness of various prehatching treatments when applied with hand equipment for control of *Aedes* mosquitoes.

Insecticide	Formulation	Dosage (pounds per acre)	Season applied	Average number of immature forms per dip: Preliminary observations [1]	Average number of immature forms per dip: Final observations	Per cent control
DDT	Fuel-oil solution	2	Fall	0.06 (1/5)	0.05	98
		1	"	.11 (2/5)	.35	83
		0.5	"	.40	.08	96
			Spring	.64	.50	76
		.1	Fall	1.26	.54	74
			Spring	.23	.05	98
		.05	"	1.29	.95	54
		.01	"	1.00	1.81	12
	Emulsion	2	Fall	<.01 (1/4)	0	100
		1	"	.47 (2/5)	.33	84
		.5	"	.52	.47	77
			Spring	.22	.25	88
		.1	Fall	.09	.05	98
			Spring	.65	.94	54
	Dust	2	Fall	.44 (3/4)	.44	79
		1	"	.42	.85	59
		.5	"	1.20	1.80	13
			Spring	1.78	1.05	49
		.1	Fall	2.38	2.41	Increase
			Spring	3.33	4.78	"
		.05	"	6.16	4.26	"
		.01	"	2.30	1.35	34
	Wettable powder	2	Fall	.13 (2/4)	.05	98
		1	"	.21	1.79	13
		.5	"	.04	.19	91
			Spring	.11	.90	56
		.1	Fall	.12	.89	57
			Spring	.63	7.30	Increase
Parathion	Fuel-oil solution	.1	"	3.18	10.89	"
		.05	"	4.18	2.33	"
		.01	"	3.28	3.72	"
TDE	"	.5	"	<.01	.11	95
		.1	"	1.85	3.07	Increase
Methoxychlor	"	.5	"	1.24	3.43	"
		.1	"	1.77	3.82	"
Chlordane	"	1.0	Fall	.72	.71	66
Toxaphene	"	1.0	"	1.05	1.11	46
Benzene hexachloride:						
12% gamma	"	1.0	"	.92	1.78	14
6% gamma (wettable powder)	"	2.5	"	.03	.23	89
Check (untreated)	—	—	—	2.31	2.06	—

[1] All plots showed breeding except as indicated—e.g., (1/5) indicates that 1 out of 5 plots was breeding.

TABLE 2. Variation in numbers of larvae per dip at different observations in moss-heath plots treated by hand with DDT in fuel-oil solution.

Dosage (pounds per acre)	Season of application	April 12	April 21	April 27	May 4	May 10	June 1
2	Fall	0	0.60	0	0.01	0.07	0.25
1	"	.18	.57	.03	.02	0	.02
0.5	"	0	.90	.52	.18	2.67	.22
	Spring	0	1.50	3.14	.56	.73	1.39
.1	Fall	.02	1.87	.48	.51	.23	.22
	Spring	0	.23	1.57	.20	.06	.06
.05	"	0	1.90	1.76	.85	1.17	.38
.01	"	.05	6.13	1.50	.22	.17	1.04
Check (untreated)	—	.05	5.10	4.67	1.62	3.00	3.48

that even the 0.01-pound dosage affected the larval population, as the average count at the final observation was never higher than the highest count during the preliminary observations.

In table 3 the data from all final observations on comparable dosages of DDT are averaged to show the effect of different environments, formulations, and seasons of application. The fall treatments were least effective in the moss-heath association and most effective in the sedge depressions, road tracks and moss-heath-sedge associations showing intermediate effectiveness. The spring treatments were least effective in the moss-heath association and most effective in the moss-heath-sedge association, the sedge depressions and road tracks showing intermediate effectiveness. In the spring fuel-oil solutions and emulsions were more effective than dusts and wettable powders. In the fall the dust was the least effective, but there was little difference between the other formulations. The variation between treatments within each association

TABLE 3. Influence of breeding environment and season of application on effectiveness of DDT treatments applied by hand, as shown by average numbers of larvae per dip at final observation.

Dosage of DDT (pounds per acre)	Formulation	Sedge depressions	Road tracks	Moss-heath	Moss-heath-sedge	Average all environments
		Fall applications				
0.5 and 0.1	Fuel oil	0.28	0.30	0.22	0.45	0.31
	Emulsion	0	.97	.09	.04	.28
	Dust	.51	1.62	4.24	2.06	2.11
	Wettable powder	0	0	.80	.37	.29
	Average	.20	.72	1.34	.73	.75
2 and 1	Fuel oil	0	0	0.89	0.12	0.25
	Emulsion	.01	0	0	.66	.17
	Dust	.05	0	2.06	.50	.65
	Wettable powder	0	.08	3.33	.15	.89
	Average	.02	.02	1.57	.36	.49
		Spring applications				
0.5 and 0.1	Fuel oil	.40	.01	.73	<.01	.29
	Emulsion	2.67	.02	1.04	0	.93
	Dust	.03	5.02	5.19	1.15	2.84
	Wettable powder	3.24	.01	6.95	.57	2.69
	Average	1.58	1.26	3.47	.43	1.69
Check (untreated)		.93	2.77	3.48	1.60	1.90

TABLE 4. Effectiveness of DDT sprays as a mosquito-prehatching treatment when applied by airplane in different dosages and seasons.

Dosage per acre		Season of treatment	Average number of immature forms per dip		Per cent control
DDT (pounds)	Solution		Preliminary observations [1]	Final observations	
2	8 qt.	Fall	0.11 (4/5)	0.51	88
1	4 qt.	"	.06 (3/5)	.15	96
0.5	2 qt.	"	.16 (4/5)	.48	88
.2	2 qt.	Spring	.45	.74	56
	1 pt.	"	.19	.78	81
.1	1 qt.	Fall	.60	.99	76
		Spring	1.64	1.32	22
	1 pt.	"	.15	.49	29
Checks (untreated):					
Fall		—	—	4.2	—
Spring		—	—	1.7	—

[1] All plots showed breeding except as indicated—e.g., (4/5) indicates that 4 out of 5 plots were breeding.

was so great that the average per dip for the fall treatments was not significantly lower than for the spring treatments.

Thirty-nine of the hand-treated plots were abandoned and the data omitted in this summary, as they were in a flood-water drainage area.

Plots Treated by Airplane.—The results from plots treated with airplane equipment are presented in table 4. From 88 to 96 per cent control was obtained with dosages of 0.5, 1, and 2 pounds of DDT per acre, and from 22 to 81 per cent with 0.2 and 0.1 pound per acre. The average number of larvae per dip was higher at the final observation than in the preliminary count in all plots except those treated in the spring with 0.1 pound of DDT per acre. No significant difference could be noted between spring and fall treatments of 0.1 pound or between the 1-pint and 1-quart applications.

In table 5 all final observations on comparable dosages are averaged to show the effect of different environments on the effectiveness of DDT as a prehatching treatment. Few or no larvae developed in plots that were located in grass depressions or moss-heath-birch, moss-heath, and moss-heath-sedge associations. The treatments were least effective in marshes containing *Myrica gale,* which occur commonly in seepage areas next to the hills and moraines on coastal flats and river flood plains. Conventional larvicide treatments likewise were least effective in this environment.

TABLE 5. Influence of breeding environment, season of application, and dosage on the effectiveness of DDT treatments applied by airplane, as shown by average numbers of larvae per dip at the final observation.

Breeding environment	Fall treatments			Spring treatments		Average
	2 pounds	1 pound	0.5 pound	0.2 pound	0.1 pound	
Grass depressions	0	0	0	—	—	0
Moss-heath	.03	0	0	.02	.04	.02
Moss-heath-birch	0	0	0	—	—	0
Moss-heath-sedge	—	—	—	.22	.42	.32
Myrica-Calamagrostis	0	.73	1.20	—	—	.64
Myrica-moss-heath	2.50	0	1.22	1.19	2.62	1.51
Myrica-moss-heath-birch	—	—	—	1.62	.54	1.08

Five of the plots treated with airplane equipment were inadvertently placed in an area that failed to hold water this season, although the marsh produced many mosquitoes in 1947. These plots were abandoned and the data are not included in this summary.

Discussion.—The results of these prehatching treatments are difficult to interpret. The newly hatched larvae are killed so rapidly that it is not possible to make accurate estimates of control on a basis of larval reduction within the treated plots. Moreover, the larval populations are so variable that control calculated on the basis of populations in untreated areas may not reflect the true effectiveness of the treatments. Hatching occurred over a period of several weeks in both treated and untreated areas. During this period larvae of all sizes were taken in the untreated areas, whereas in the treated plots only newly hatched larvae were present. This difference, as well as the difference in total populations, indicates that the larvae were being killed in the treated area shortly after hatching.

The data indicated that prehatching treatments could be relied upon to give satisfactory control except in *Myrica* marshes. The reasons for the lack of effectiveness in this type of breeding area were not determined. However, the fact that treatments both in the fall, when *Myrica* marshes were relatively dry, and in the spring, when they were covered with snow, were ineffective suggests that soil or water conditions in such areas may inactivate the DDT.

The practicability of prehatching treatments as a routine control method in much of this region is questionable. Further studies, however, may show this method to have a wider application than the present data indicate. Owing to the long flight range of Alaskan *Aedes* and the many square miles of breeding area adjacent to inhabited communities, it is likely that better mosquito control could be obtained with the same total amount of material applied by other methods. For example, at least 0.5 pound of DDT per acre was necessary in the prehatching treatment, whereas 0.1 pound was sufficient for conventional larvicidal treatments or for control of adults.

The prehatching method of control may be practicable in localities where mosquitoes are produced on localized breeding areas, such as exist in much of the Anchorage area. Many of these locations have little run-off, so that heavy dosages can be applied without danger to wildlife. It will be especially important to continue observations on the areas where the amount of DDT applied during the year totals 0.5 pound or more per acre. It is not unreasonable to expect a general reduction in mosquito breeding in such areas.

Summary.—The relative effectiveness of several of the new insecticides as prehatching treatments was determined from 201 plots treated with hand equipment and 40 plots treated by airplane. The plots were located in five different mosquito-breeding environments. Half the plots were treated in August 1947 and half in March and April 1948 when the snow was 3 to 30 inches deep.

In the plots treated with hand equipment in the fall, complete control was obtained only with 2 pounds of DDT per acre as an emulsion, but 90 per cent or higher control resulted from the same dosage of DDT as a fuel-oil solution, emulsion, and wettable powder, and from 0.5 pound in fuel oil and wettable powder, and 0.1 pound as an emulsion. Plots treated in the fall by airplane with 1 pound of DDT per acre averaged more than 90 per cent control. In the spring treatments only the 0.1 pound dosage of DDT in fuel oil and 0.5 pound of TDE gave as much as 90 per cent control when applied with hand equipment.

From 70 to 89 per cent control was obtained with fall applications of a minimum of 0.1 pound of DDT in fuel oil, 0.5 pound in an emulsion, and 2 pounds in

a dust, with 0.5 pound of the gamma isomer of benzene hexachloride applied as a wettable powder (6 per cent gamma), when applied with hand equipment. Similar control was obtained with 0.5 pound of DDT in fuel oil and in emulsion, when applied by airplane in the spring. DDT was more effective in fuel-oil solution and in emulsions than in dusts or wettable powders. There was no significant difference between fall and spring treatments, but there was a large difference in effectiveness in the various environments. The treatments were least effective in marshes containing the shrub *Myrica,* and most effective in grassy depressions.

Literature Cited

DEONIER, C. C. FLUNO, J. A., AND NOTTINGHAM, E. 1948. Preflooding treatments with DDT for mosquito control. Science 107:63–64.

HANSENS, E. J., AND HART, L. T. 1947. "Preflood" treatment for flood water mosquitoes on upland areas. N. J. Mosquito Extermin. Assoc. Proc. 34:136–143.

HORSFALL, W. R. 1946. DDT used to control a rice-field mosquito, *Psorophora confinnis.* Jour. Econ. Ent. 39:723–725.

LINDQUIST, A. W., ROTH, A. R., AND YATES, W. W. 1948. DDT as a prehatching treatment for the control of snow-water mosquitoes. U. S. Bur. Ent. and Plant Quar. E-760, 2 pp. [Processed].

MCDUFFIE, W. C., SHARP, J. F., CROSS, H. F., TWINN, C. R., AND WILSON, W. M. 1949. The effectiveness of prehatching treatments for the control of arctic mosquitoes. Mosquito News (Companion to this paper).

ROTH, A. R., YATES, W. W., AND LINDQUIST, A. W. 1947. Preliminary studies of larvicides on snow-water mosquitoes. Mosquito News 7:154–156.

WISECUP, C. B., BROTHERS, W. C., AND EIDE, P. M. 1945. Airplane spraying of rice fields with DDT to kill mosquito larvae. Jour. Econ. Ent. 38:686–688.

WISECUP, C. B., AND DEONIER, C. C. 1945. DDT for the control of *Psorophora* mosquitoes. Jour. Econ. Ent. 38:250–252.

WISECUP, C. B., WHITE, W. C., AND MINNICH, V. S. 1947. Airplane spraying with DDT for control of salt-marsh mosquito larvae. Mosquito News 7:103–108.

YATES, W. W., AND GJULLIN, C. M. 1947. Prehatching applications of DDT larvicides on floodwater *Aedes* mosquitoes. Mosquito News 7:4–6.

A METHOD FOR ARTIFICIALLY FEEDING MOSQUITOES

JOSEPH GREENBERG

Laboratory of Tropical Diseases, Microbiological Institute, National Institutes of Health, Bethesda 14, Maryland

There are several reasons for feeding mosquitoes and other blood-sucking insects on whole blood or other fluids off the host. Bishop and Gilchrist (1) used the artificial feeding technique to obtain malaria sporozoites in a medium of known composition. The author, following Woke (2), has used the method to determine food factors essential for oviposition by *Aedes aegypti.*

One of the fundamental considerations in any artificial feeding tehnique is to attract the insects to the proffered fluid. It is well known that some mosquitoes are positively thermotropic and this phenomenon can be used to attract them to the fluid which is offered. To do this, a warming apparatus was designed employing electrically heated resistance wires as a source of heat. The apparatus was made to accommodate six lantern globe cages, each having its own heating element to warm the feeding tube.

The heating element (Figure 1) consisted of 28-gauge nichrome wire strung between two asbestos rings which were held 50 mm. apart by three brass rods. Nuts on these rods allowed for tightening the wire after it had been strung. The inside diameter of the asbestos rings was

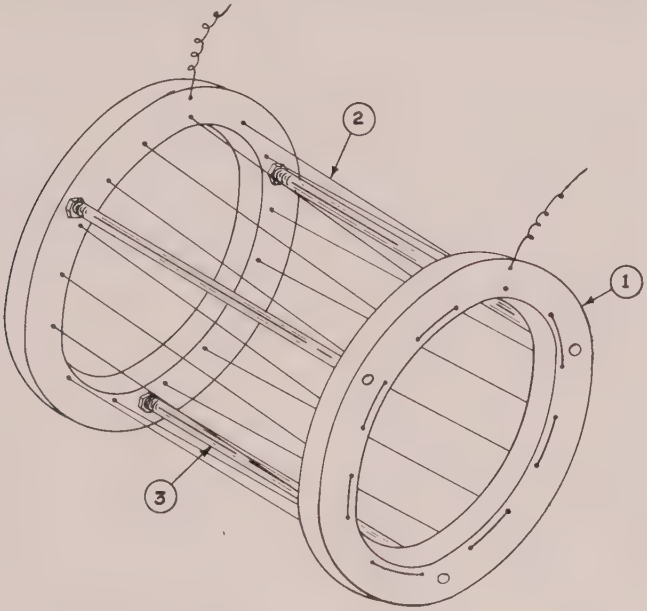

FIG. 1. Heating Element—(1) Asbestos ring; (2) Nichrome wire; (3) Brass supporting rod.

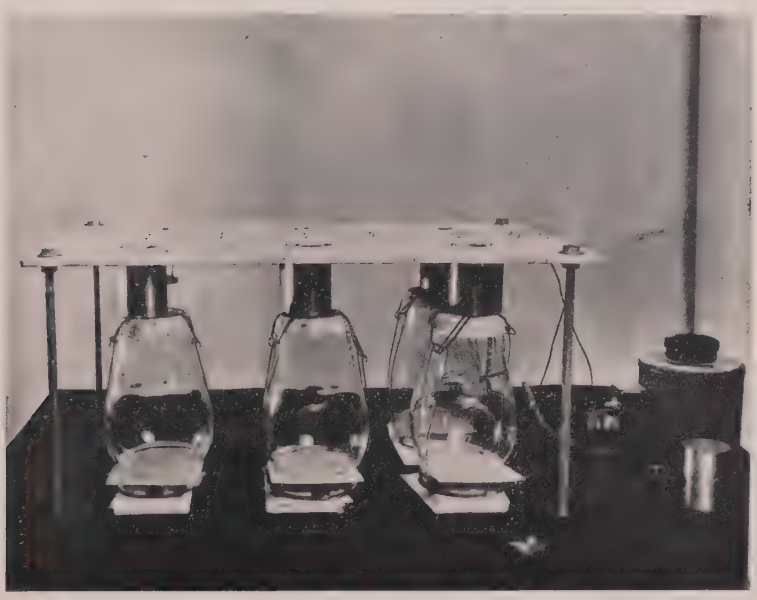

FIG. 2. Feeding apparatus with lantern globe cages and variable transformer.

30 mm. which was large enough to accommodate the glass feeding tube. Each unit had 16 turns of wire, the entire coil being enclosed in a brass cylinder 65 mm. long and 35 mm. inside diameter. Six such units were mounted in an inverted position, 180 mm. apart, on an asbestos insulating board mounted on metal legs. These legs were adjustable in height. Holes were bored through the insulation board at the position of the heating units so that the feeding vials could be inserted from above. All the heating elements were connected in parallel with insulated wire and two brass conductors on the under side of the insulating board. The current passed from an AC lead through a variable transformer to the heating elements. The variable transformer regulated the current passing through the wires and hence the amount of heat generated. It was important to heat the nutrient fluids up to but not exceeding body temperature.

The feeding vials were made of ordinary glass tubing 22 mm. inside diameter cut so that they were about 65 mm. long. One end of the tubing was covered with a membrane through which the mosquitoes could feed. The Baudruche membrane, manufactured and distributed by Mrs. Elizabeth Troeder, Belleville, New Jersey, was suggested by Dr. Dwight DeLong and has worked quite well. A small piece of this membrane was wetted with distilled water, stretched across the mouth of the feeding tube and allowed to dry. It was then thin and water tight, retaining all the fluids tested including physiological saline and whole blood. The mosquitoes were able to probe and feed through it.

Artificial membranes such as cellophane have been unsuccessful. Animal skins variously prepared from different sources have been used with success, but they are not easily prepared in large numbers.

Up to 50 mosquitoes were kept in cages made from lantern globes with bobbinet tops. One such cage was placed under each heating element (Figure 2). Minor adjustments were necessary to make the bobbinet top just reach the heating elements. A feeding vial containing 2 to 3 ml. of test fluid was introduced into the heating element so that the membrane rested on the netting of the cage. A thermometer was placed inside each vial and regulation of the temperature through the variable transformer was made at ten-minute intervals.

The apparatus and method described have been used to feed large numbers of *Aedes aegypti* on a wide variety of artificial fluids. The procedure may be adapted for the feeding of other thermotropic blood-sucking insects.

Literature Cited

1. BISHOP, A. AND GILCHRIST, B. M. (1946). "Experiments upon the feeding of *Aedes aegypti* through animal membranes with a view to applying this method to the chemotherapy of malaria." Parasitology, *27*, 85–100.
2. WOKE, P. A. (1937). "Effects of various blood fractions on egg production of *Aedes aegypti* Linn." Am. J. Hyg. *25*, 372–380.

PLEASE MARK YOUR CALENDAR

For the 1950 Annual Convention of the AMCA to be held jointly with the Virginia Mosquito Control Association at the famous Cavalier Hotel, Virginia Beach, Va., February 23 and 24. A program of outstanding speakers and entertainment of exceptional interest is being planned. ATTENTION IS CALLED to the contemplated motorcade which will leave after the meetings and terminate the next week in New Jersey in time for all to enjoy the annual convention of the New Jersey Mosquito Extermination Association. CONSULT "Mosquito News" from time to time for details.

THE EFFECTIVENESS OF PREHATCHING TREATMENTS FOR THE CONTROL OF ARCTIC MOSQUITOES [1]

WILLIAM C. MC DUFFIE,[2] J. F. SHARP,[3] H. F. CROSS,[2] C. R. TWINN,[3] AND W. M. WILSON [4, 5]

Recent reports by a number of workers have shown that good control of certain species of mosquitoes may be obtained by applying DDT to the breeding areas before they are flooded. Such treatments were found effective against *Psorophora* by Wisecup and Deonier (1945), Wisecup *et al.* (1945), and Horsfall (1946), and against salt-marsh *Aedes* by Deonier *et al.* (1948). Prehatching treatments were also found to be effective against floodwater *Aedes* by Yates and Gjullin (1947) and against mountain snow-pool breeding species by Roth *et al.* (1947).

In view of these promising results, preliminary studies on small plots with several insecticides were undertaken at Churchill, Manitoba, Canada, during the spring of 1947 to determine whether treatments applied to the snow and ice covering breeding areas would control breeding of arctic and subarctic species of *Aedes*. Owing to the difficulty attending movement by vehicle or on foot after the spring thaw, and the short season of larval development, it was thought that this method might be an easier and more effective means of achieving control under arctic conditions than conventional larvicide applications.

Promising results were obtained from the initial tests at Churchill in 1947, especially with DDT. Further studies in 1948 included comparative tests with DDT and several other new insecticides on small plots, and applications of DDT by airplane on large areas. The airplane tests were designed to determine the optimum concentration, volume of solution, and dosage of DDT per acre for control of mosquitoes on a practical scale. These tests also afforded an opportunity to study the feasibility of aerial spray operations under arctic winter conditions. The results of the studies during the 2 years are presented in this paper.

Test Conditions and Methods. *Hand Applications.*—In 1947 the first prehatching treatments were applied on May 24 to terrain that was frozen and covered with about 2 feet of packed snow. The last treatments were applied on June 4 to plots partly free of snow and containing partly thawed pools and grassy depressions. During this period daily temperatures ranged from near zero at night to a maximum of 28° F. during the day. By June 8 many areas were free of snow, and newly hatched larvae were present in scattered pools and flooded, grassy depressions. By June 15 the greater part of the open tundra was free of snow and ice and the larval population was at a peak.

In 1948 the small plots were treated during late April and early May, when the terrain was frozen and covered with snow and ice to a depth of 6 inches to 3 feet or more. Daily temperatures were comparable with those in 1947. An early thaw occurred in 1948, and by May 15 very little snow remained on the open

---

[1] The results herein reported were obtained through the joint efforts of the Canadian Division of Entomology, on behalf of the Canadian Defense Research Board, and the U. S. Bureau of Entomology and Plant Quarantine, on behalf of the Army Committee for Insect and Rodent Control.

[2] U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine.

[3] Canadian Dept. Agr., Division of Entomology, Science Service.

[4] Captain, Air Corps, U. S. Army.

[5] Acknowledgment is made of the valuable contributions of the following members of the joint U. S.-Canadian group: In 1947, J. B. Goldsmith, Major, Sn.C., U. S. Army; C. N. Husman, U.S.D.A.; and R. W. Fisher, Canada; in 1948, Douglas Peterson and John Rooks, Canada; L. A. Tegner, 1st Lt. Air Corps, U. S. Army; and crew members of the plane provided by the 300th AF Base Unit, Tactical Air Command, Langley Field, Va.

tundra. Most of the pools contained larvae. Cold weather during the latter part of May retarded hatching and larval development, but by early June the entire terrain was free of snow and the larval population was at a peak.

Most of the small plots were located on the open, marshy tundra flats; the remainder were in open pool areas. Of 48 plots treated in 1947, 30 were 2 acres in size, and the remainder were from 0.5 to 1 acre. In 1948 all the plots were 1 acre in size.

In 1947 four insecticides were applied at dosages ranging from 0.1 to 1 pound per acre. DDT was tested in a fuel-oil solution, in a xylene-Triton X-100 [6] emulsion, as a 50 per cent wettable powder, and as a 10 per cent dust. Chlordane and toxaphene were used in fuel-oil solution and as wettable powders. The chlordane powder contained 50 per cent of active ingredient and the toxaphene powder 25 per cent. Benzene hexachloride (20 per cent gamma) was applied only in a fuel-oil solution. Spray materials were applied at 2.5 gallons per acre with hand-pressure equipment and with a power unit mounted on a "weasel" (cargo carrier, M-29). The percentage of toxicant was varied to provide the desired dosages. DDT dusts were applied with rotary hand dusters. Swath intervals of 25 feet were maintained in all tests.

In 1948 tests on small plots were made with DDT, TDE, methoxychlor, heptachlor, and parathion. Parathion was applied as a 15 per cent wettable powder and the other materials as oil solutions. The experimental dosages were applied in 1 gallon of water or oil per acre with hand-pressure sprayers. Swath intervals of about 25 feet were maintained in treating each plot.

The effectiveness of prehatching treatments on small plots was determined by comparing larval counts in the treated areas with counts in adjacent untreated check areas. Plots were dipped for larvae as soon as water appeared, and at 4- or 5-day intervals thereafter until only mature larvae or pupae remained in untreated areas. The dipping was done by two to four men, and from 100 to 200 dips were taken at random in each plot.

Aerial applications.—The aerial sprays were applied from April 29 to May 7, 1948, on lightly forested tundra areas that were covered with 3 to 8 feet or more of snow. The forest cover consisted of light to moderate stands of spruce and larch, averaging about 25 feet in height, interspersed with light to moderate densities of dwarf willow and birch. Virtually all of the latter growth was covered with snow at the time of treatment. Several of the plots were barren except for dwarf willow and birch. Each test plot was 1 mile long and ½ mile wide, and each was separated by an area of similar size, which later served as a check.

The C-47 plane used in the tests was equipped with a standard U. S. Air Force spray unit consisting of a cargo tank (capacity 670 gallons) which emptied by means of gravity through a single discharge pipe. Several interchangeable pipes calibrated to deliver from 13.5 to 32 gallons per minute were available. Sprays were applied from altitudes of 75 to 100 feet, at a plane speed of 160 mph. Flights were made primarily with or against the wind, which ranged from 6 to 10 mph during the spraying. Air temperatures ranged from 22° to 31° F. A swath interval of 300 feet was maintained in the six basic comparative tests, whereas in others it was varied from 225 to 600 feet.

In the aerial spray tests 5-, 10-, and 20-per cent DDT-oil solutions were compared. Standard airplane spray solution (20 per cent of DDT, 40 per cent of Velsicol AR-50,[7] and 40 per cent of fuel oil) was used, undiluted and diluted appropriately with fuel oil to give 10 and 5 per cent solutions. Single plots were treated in 300-foot swaths with 1.1 and 1.8 pints

[6] An aralkyl polyether alcohol.

[7] Chiefly mono- and dimethylnaphthalenes.

per acre of each strength of solution, to give dosages of DDT ranging from approximately 0.05 to 0.33 pound per acre. One plot was treated with 0.5 pint of 20 per cent solution at swath intervals of 600 feet. Two other plots were treated with 3.3 and 6.7 pints per acre of 5 per cent solution at swath intervals of 225 feet. The higher dosage was obtained by traversing the area twice at 225-foot intervals.

The plots were dipped first early in June, when hatching was complete and most of the larvae in the check areas were in the second or third instar. A second check was made 1 week later, when all the larvae were mature or had pupated. Dipping counts were made by two to four men traversing the center half of each plot. Five dips in each of at least 50 pools or other dipping stations was established as the standard sample for each observer. This standard was met or exceeded in all except two plots where breeding spots were few and widely scattered.

The per cent control was calculated by comparing the larval counts in the treated plot with those in the check plot, and also by comparing the number of dipping stations where larvae were found in the treated and check plots.

Results. *Hand Applications.*—The results of small-plot tests in 1947 and 1948 are summarized in table 1. In the 1947 small-plot tests, DDT as a wettable powder and an emulsion gave complete control of larvae at the lowest dosage tested—0.1 pound per acre. A fuel-oil solution at 0.25 pound per acre and a dust at 0.4 pound gave nearly complete control. On the basis of results with fuel-oil solutions, DDT was the most effective of the four materials tested.

Chlordane in oil provided excellent control at dosages of 0.25 to 0.5 pound per acre. The wettable powder was also effective, except at 0.25 pound per acre. Toxaphene and benzene hexachloride (20 per cent gamma) in fuel-oil solution appeared inferior to the other compounds, but as a wettable powder toxaphene provided complete control at 0.1 pound or more per acre. When compared on the basis of the gamma isomer, the benzene hexachloride was equal to DDT in fuel oil.

In the 1948 tests DDT, TDE, and

TABLE 1. Per cent control of *Aedes* mosquito larvae obtained with various formulations of DDT and other insecticides applied by hand as prehatching treatments at various dosages per acre.

Insecticide	Formulation	1.0 lb.	0.5 lb.	0.25 lb.	0.1 lb.	0.05 lb.
		1947 Tests				
DDT	Fuel oil	100	100	99	79	—
	Wettable powder	100	100	100	100	—
	Emulsion	—	100	100	100	—
	Dust	—	95 [1]	68	—	—
Chlordane	Fuel oil	96	100	92	58	—
	Wettable powder	100	96	67	100	—
Toxaphene	Fuel oil	100	74	33	33	—
	Wettable powder	100	100	—	100	—
Benzene hexachloride (20% gamma)	Fuel oil	—	78	79	—	—
		1948 Tests				
DDT	Fuel oil [2]	—	—	97	76	79
TDE	"	—	—	96	85	71
Heptachlor	"	—	—	—	79	76
Methoxychlor	"	—	—	85	59	50
Parathion	Wettable powder	—	—	—	—	0

[1] Dosage 0.4 pound per acre.

[2] Fuel oil alone gave 34 per cent control at 1 gallon per acre, and 31 per cent at 2.5 gallons per acre.

heptachlor appeared about equally effective. Fuel-oil solutions of these materials applied at 0.05 and 0.1 pound per acre failed to give satisfactory control. At 0.25 pound per acre DDT and TDE gave 97 and 96 per cent control. Methoxychlor was markedly less effective than DDT, TDE, and heptachlor. Parathion at 0.05 pound per acre proved totally ineffective as a prehatching treatment, although in subsequent tests against mature larvae this material proved slightly more toxic than DDT.

Aerial Applications.—The results of the aerial treatments are given in table 2. Four of the five treatments in forested areas gave 85 to 95 per cent control. A fifth forested plot treated at an extended swath interval of 600 feet showed only 71 per cent control. The pattern of breeding in this plot clearly showed that the swath interval was too great for complete coverage. The results from these five tests in typical lightly forested terrain indicated that a dosage as low as 0.05 pound per acre, applied at a swath interval of 300 feet, would provide good, but not complete, control of larval breeding.

On open, eroded tundra and on areas partly forested and partly open tundra, higher dosages were required. Satisfactory control was obtained in only one of four plots treated at 0.09 to 0.35 pound per acre. The disparity in the results from the different areas may be attributed, at least in part, to the differences in speed of drainage and in the seasonal development of mosquito larvae. In forested areas melting of the snow was gradual, drainage relatively slow, and the predominant species of mosquito, *Aedes communis* (Deg.), hatched almost immediately in the mossy pools and grassy marshes and so was exposed to the highest concentration of insecticide. In open, eroded tundra, conditions favored rapid melting and run off, probably resulting in loss of insecticide before hatching was completed. Good control of the early hatching species, such as *Aedes nigripes* (Zett.) and *A. punctor* (Kby.), was indicated, but not of the late-hatching species, *A. campestris* (D. and K.). In one open area, where the control was 74 per cent, virtually all the surviving larvae were *A. campestris,* while in check areas at least three species were present. These results indicate the need for heavier dosages of DDT on open areas. They also suggest that treatments applied before snow fall might be more effective.

In general, these studies do not show that the prehatching method of control is superior to conventional larvicide treatments. However, they do indicate that effective control can be obtained under certain conditions and that in some areas prehatching treatments may be more convenient.

Summary.—The effectiveness of prehatching treatments for the control of arctic mosquitoes was studied in 1947 and 1948 at Churchill, Manitoba, Canada. These treatments were applied before the spring thaw, to snow and ice covering potential breeding areas. Comparative tests on small plots were made with DDT and seven other promising new insecticides applied by hand equipment. DDT was also applied by a C-47 airplane to determine the practical possibilities of controlling mosquitoes over large areas.

In the small-plot tests DDT in a wettable powder (50 per cent) and an emulsion gave complete control of larvae at 0.1 pound per acre. DDT in a fuel-oil solution gave nearly complete control at 0.25 pound per acre, and in a dust at 0.4 pound. Toxaphene in a wettable powder (25 per cent) provided complete control at 0.1 pound per acre. When applied in oil solution, DDT, TDE, and heptachlor were about equal in effectiveness. Chlordane and methoxychlor were slightly and toxaphene considerably less effective than DDT. Benzene hexachloride was equal to DDT when compared on the basis of the gamma isomer. Fuel oil alone, applied at 1 and 2.5 gallons per acre, was rela-

Table 2. Control of *Aedes* mosquito larvae with DDT-oil solutions applied by C-47 airplane to snow and ice as prehatching treatments.

Test. No.	Temperature (° F.)	Wind speed (mph)	Swath interval (feet)	Strength of solution (per cent)	Dosage of DDT (pounds per acre)	Number of dipping stations	Per cent of stations breeding	Average number of larvae per dip	Per cent control based on —	
									Dipping stations	Larval counts
				Spruce-larch forest						
5	31	8	600	20	0.11	191	25	0.8	67	71
6	31	8	300	20	.22	197	5	.2	91	85
8	29	9	300	10	.11	243	12	.1	78	89
7	22	6	300	5	.05	299	17	.2	80	95
9	30	9	225[1]	5	.33	284	5	.4	94	90
Checks:										
No. 5	—	—	—	—	—	165	75	2.7	—	—
Nos. 6 & 8	—	—	—	—	—	133	56	1.2	—	—
Nos. 7 & 9	—	—	—	—	—	153	83	4.3	—	—
				Mixed forest and open tundra						
1	31	8	300	10	.18	290	5	.04	93	98
3	22	6	300	5	.09	133	51	1.5	32	44
Check	—	—	—	—	—	165	75	2.7	—	—
				Largely open, eroded tundra						
2	29	9	300	20	.35	207	20	.2	64	74
4	29	10	225	5	.17	196	66	1.3	0	0
Check	—	—	—	—	—	191	56	.8	—	—

[1] Area sprayed twice to obtain the desired dosage.

tively ineffective. Parathion in a wettable powder (15 per cent) was completely ineffective at 0.05 pound per acre, the highest dosage tested.

In the airplane tests treatments in forested areas with DDT-oil solutions at dosages of 0.05 to 0.22 pound of DDT per acre gave 85 to 95 per cent control, except in one plot treated in 600-foot swath intervals when 71 per cent control was obtained. In tests on open, eroded tundra and on mixed forest and open terrain, dosages of 0.09 to 0.35 pound per acre gave satisfactory control in only one of four plots.

The results obtained in these tests indicate that prehatching treatments, although not superior to conventional larvicide treatments, may be used for the control of arctic species of mosquitoes. The requirements for control, however, may differ greatly according to the type of terrain.

Literature Cited

DEONIER, C. C., FLUNO, J. A., AND NOTTINGHAM, E. 1948. Preflooding treatments with DDT for mosquito control. Science 107:63–64.

HORSFALL, WILLIAM R. 1946. DDT used to control a rice-field mosquito, *Psorophora confinnis*. Jour. Econ. Ent. 39:723–725.

ROTH, A. R., YATES, W. W., AND LINDQUIST, A. W. 1947. Preliminary studies of larvicides on snow-water mosquitoes. Mosquito News 7:154–156.

WISECUP, C. B., BROTHERS, W. C., AND EIDE, P. M. 1945. Airplane spraying of rice fields with DDT to kill mosquito larvae. Jour. Econ. Ent. 38:686–688.

WISECUP, C. B., AND DEONIER, C. C. 1945. DDT for the control of *Psorophora* mosquitoes. Jour. Econ. Ent. 38:250–252.

YATES, W. W., AND GJULLIN, C. M. 1947. Prehatching applications of DDT larvicides on floodwater *Aedes* mosquitoes. Mosquito News 7:4–6.

ANOPHELES GAMBIAE MELAS CONTROL BY SWAMP DRAINAGE IN A COASTAL ZONE OF NIGERIA, BRITISH WEST AFRICA

LEONARD JAN CHWATT, M.D., D.T.M. & H.
Medical Department, Nigeria (B.W.A.)

The modern trend of malaria control is so dominated by the success of residual insecticides that a paper dealing with mosquito control by swamp drainage seems to be out of date. Nevertheless its aim will be reached if it provides a proof that even to-day the engineering methods of mosquito control based on the knowledge of the bionomics of the species involved and on a naturalistic approach to the technique of control can be highly successful.

At the very outset of this paper it must be made clear that the highly effective method of control of *A. gambiae melas* in West Africa was initiated and carried out by Dr. Alan B. Gilroy, O.B.E., who started the Lagos reclamation scheme as a military expediency in 1942 and expanded it by 1947 to its present size.

The Lagos reclamation scheme originated when the capital of Nigeria became one of the nodal points of the Transcontinental Ferry Service of the Royal Air Force. This service was organized to keep up the steady supply of front line aircraft for the Middle East theatre of war when the Mediterranean route was blocked. Fighter planes for the Middle East were shipped from Britain to West Africa in crates. Takoradi (Gold Coast) and Lagos (Nigeria) served as main bases for the assembly and test flights of these single-engined aircraft. From these two bases planes were flown across Africa in "air-caravans" consisting of 6–8 fighter planes following the leader—a light bomber with navigational facilities. The air route was across Nigeria, French East Africa, Sudan and then up the Nile valley to Cairo.

In 1943 and 1944 the Transafrican air

route saw an ever increasing flow of heavy aircraft of the U. S. A. Air Force.

As early as 1941 it became obvious that the Air Force base in Lagos, situated for the sake of convenience in the immediate vicinity of the harbour at Apapa, presented a great malaria risk to both the flying and ground personnel, as the harbour was within ½ mile of extensive mangrove swamps, breeding high numbers of mosquitoes.

In the early days of the war when residual insecticides were unknown, suppressive drugs and repellents in their infancy, and the malaria risk not fully appreciated, one had to rely on mechanical protection and on obsolete methods of malaria control.

"—500 blood-fed Anopheline females were captured day after day in each one-man tent of an anti-aircraft battery . . . 80% of all ranks of this battery contracted

Aerial view of part of the drainage scheme at Apapa showing the sluice gate, the bund with the facade drain and the inland system of channels.

malaria within 3 months of arrival at Apapa . . . the malaria morbidity rate at the nearby R.A.F. station was 100 per 1000 per week for many weeks at a time" (Gilroy 1948).

It soon became very obvious that the extent and inaccessibility of the coastal swamps at Apapa presented a problem that could not be dealt with by piecemeal methods of control.

In mid 1942 it was decided to drain the main swampy area in the close vicinity of the airport. This pilot project was so successful and its beneficial effects felt so soon that the drainage work was extended to the neighbouring swampy islands within the 1-mile perimeter of the airbase and the harbour, and during the next two years well beyond this perimeter to areas where the entomological survey had revealed the breeding of the main malaria vector.

In 1945, encouraged by the lasting success and relative speed of this method of control, the Nigerian Government created a Malaria Unit working under the aegis of the Medical Department, obtained the services of the former military personnel in charge of the original reclamation scheme and extended this method of control to marshes situated within the Lagos township area. By 1947 the total area reclaimed by swamp drainage covered over 6 sq. miles.

2. Description of the Area

The climate of Lagos is typical of the Guinea type of equatorial climate. There is a "dry season" lasting from November to March, and two wet seasons; the "big rains" from May to July and the "little rains" throughout September and October. This double peak of the rainfall is due to the northward and southward swing of the equatorial low pressure trough in the wake of the zenithal sun. The average rainfall is 72 ins. of which about 60% falls during the "big rains".

The temperature is such that no month has a lower mean than 75° F. Accompanying the constant heat there is usually a high degree of humidity. In general the meteorological conditions during the year, except for two months during the peak of the dry season, are never unfavourable to mosquito breeding and to their survival in the adult stage.

The tides in the Lagos area are of interest since they contribute to the creation and maintenance of anopheline breeding. The ranges between high and low water neap tides average 2 feet. During the ordinary spring tides occuring twice a month, this range is increased to 3 feet. Equinoctial spring tides may occasionally reach the 5 foot mark.

Lagos is situated on an island between the Bight of Guinea and a large lagoon. To the north and west of the main island there are low sandspits and mangrove swamps; to the southeast and south there are several islands covered with mangroves and separated by a maze of creeks. The greater part of the foreshore presents vast stretches of flat lowland covered with a fringe of mangrove of variable width or with a dense and coarse mat of salt marsh grass.

The topography of the coastal area has a direct connection with its ecological aspects and with its importance as a mosquito breeding area. This relationship is not unlike that found by Sir M. Watson in the Malay Penisula in relation to *Anopheles umbrosus*. From the shore towards the mainland one can recognize 3 separate swamp zones which are sufficiently distinctive to be of great practical value. The first zone is a swampy foreshore with tongue-like projections along the mouth of the creeks and completely submerged by the diurnal high tides. The second zone has a slightly higher level (2–3 ft. above mean sea level) and is submerged twice monthly by the spring tides. The third zone is still higher (4–5 ft. above mean sea level) and submerged only twice a year by the very high equinoctial spring tides.

The typical vegetation of the first zone is composed of a tangle of branches and aerial roots of the red mangrove *(Rhizo-*

Inland fringe of an untouched mangrove swamp between the Rhizophora and Avicennia zones. Note numerous shallow pools breeding *An. gambiae melas.*

phora racemosa May) growing in a bed of black mud flats. The second zone is composed either of large patches of white mangrove (*Avicennia nitida* Jaq.) growing in patches of bare sandy soil or surrounded by salt marsh grass *(Paspalum vaginatum).* The white mangrove tree is very different from the red mangrove; while the latter consists mainly of a dense tangle of aerial stilt roots with hardly any trunk (as seen in Lagos), the *Avicennia* tree has a large and handsome crown supported by an often contorted trunk which is surrounded at the base by thousands of erect aerial rootlets sticking out of the ground.*

The treeless *Paspalum* grass-fields of the second zone extend for many acres in

* The West African mangrove species are also components of the South and Central American mangrove swamps. "Red Mangrove" is a general name for *Rhizophora.* The "White mangrove" of West Africa is called "black mangrove" or "honey mangrove" in the West Indies and in Florida. The "White Mangrove" of Florida is *Laguncularia racemosa* Gaertn, which occurs in West Africa only as a shrub.

the form of a thick, matted carpet hiding numerous shallow pools and puddles. Finally the third zone has a transitional type of vegetation composed of shrubs, salt water ferns *(Acrostichum aureum)*, and false date palms *(Phoenix reclinata)*.

The distinctive vegetation of each of these three littoral zones has an important bearing on the anopheline breeding as recognized in Sierra Leone by Thomson. (1945).

There is never any breeding in the first zone, distinguished by the presence of a continuous belt of the *Rhizophora* mangrove. On the other hand the second, spring-tide zone is responsible for most of the anopheline breeding. These breeding foci are numerous shallow pools round the *Avicennia* clumps or, to an even greater extent, widely scattered over the vast *Paspalum* grass flats, covered by the spring high water which remains there for 10–12 days during the dry season and is practically permanent during the wet season. In the third zone breeding places occur for a short time, mainly during the rainy season, although more permanent breeding may be found in patches where seepages are very pronounced.

3. Malaria Situation

Like most of the British West Africa the area round Lagos shows the typical picture of malarial hyperendemicity. The transmission of the infection is practically perennial. The amount of malaria in the indigenous population assessed by repeated investigations of the child population, below the age of 10 years shows parasite rates varying between 75 and 90 per cent, with corresponding spleen rates varying between 60 and 80 per cent. Parasite rates in African children are usually higher than spleen rates, a fact which indicates a high degree of acquired immunity, particularly in the second quinquennium of age.

Plasmodium falciparum is the main parasite species with a frequency of 70 to 100 per cent of all infections. *P. malariae* is fairly common in African children—16 to 20 per cent of all infections. *P. vivax* and *P. ovale* are found in 0.5 to 2.0 per cent of African children. Mixed infections are common, the usual association is that of *P. falciparum* and *P. malariae*.

Malarial morbidity is difficult to assess in the African population. Child mortality due to malaria amounts to about 10 per cent of all African children admitted to the Lagos hospital. It seems to be the highest in the 2–3 age group. The actual amount of infant mortality due to malaria has not been reliably assessed. The malaria morbidity in the resident non-immune European population is difficult to assess on account of the general use of suppressive drugs. However the frequency of malaria in the transient non-immune population has been investigated during the war on the British Military personnel stationed in Nigeria during the war. In 1941 and 1942 the incidence of malaria per 1000 strength per year was 564 and 525 respectively.

4. The Vector

Anopheles gambiae Giles, the main malaria vector throughout tropical Africa, is also the main malaria vector along the West Coast. The presence of a dark melanic variety of *A. gambiae* was first reported from the Gambia by Theobald (1903) who referred to adults with dark integument, with an additional fourth dark band on the maxillary palps and a considerable reduction of pale spots on wings and of pale rings on tarsi. Barber and Olinger (1931) working in Lagos brought to light the association between dark forms of *A. gambiae* and their breeding in brackish water along the coast. Ribbands (1944) found that in Freetown (Sierra Leone), of mosquitoes bred out of eggs laid by these four-banded melanic varieties, only about 30% of females had the additional band, the remainder showing no difference from typical *gambiae*. This author concluded that some coastal mosquitoes hitherto regarded as typical *gambiae* must be of the melanic variety, although they do not show any obvious signs of melanism. The same author decided that the high tolerance to

salt water of the larvae of the melanic variety of *A. gambiae* and the character of the larval pecten warrant this variety to have a specific status of *A. melas*. This view was upheld by Thomson (1945) on the basis of differences between the eggs of *A. gambiae* type and *A. melas* and later (1947) supported by the same author on the basis of sterility of the male hybrids. The presence of an additional fourth band which was thought at first to be the distinguishing feature of *A. gambiae melas* is known now to be of little taxonomic importance. In the Lagos area in over 95% of *A. gambiae melas* this additional band is missing while on the other hand four-banded *A. gambiae* have been found several hundred miles away from the coast.

Many efforts to find an additional morphological feature that would allow the distinguishing of adult *gambiae* from adult *melas* have failed (Chwatt 1945).

It seems that the egg character is the only relatively reliable means of distinction. This applies of course only to gravid females. There is no way of telling the difference between wild males or non-egg laying females of the two mosquitoes. Some investigators consider that even the morphological differences of eggs of the two mosquitoes are not absolutely consistent and that they are not always constant in two successive generations. Thus they maintain that *A. melas* is merely a biological race of *A. gambiae,* different from the type form mainly by its ecological preferences, adaptation to sea water and geographical distribution (Chwatt 1945).

The problem of specificity of *A. melas* is still not completely solved and rather obscured again by the recent discovery in East Africa of *A. gambiae* with a typical structure of the egg and yet with a high tolerance to sea water.

The present position is certainly rather troublesome to a taxonomist who finds the borders between the concept of species and variety extremely vague. We may be dealing here with two sibling species (Mayr), the areas of whose distribution overlap and which are morphologically almost identical, but have specialized habitats and are reproductively isolated. We may on the other hand be dealing with a biological race; meaning by this a group isolated to some extent by food preferences, occurring in the same locality and showing differences in biology without any great structural differences. Whether we call *A. melas* a sibling species or a biological race depends to a great extent on whether the present taxonomic classification of Culicidae is based on a morphological concept or on a wider biological approach. It is true that the modern tendency among the geneticists is rather to stress the biological differences by separating into species all the groups that would previously have been regarded as varieties.

B. de Meillon (1947), in following the general attitude of the systematists of the Culicidae, regards *A. melas* as a variety and not as a distinct species. In view of the present still uncertain taxonomic position of *A. melas,* a trinomial nomenclature will be used in the present paper: *A. gambiae* type being designated as *A. gambiae gambiae* and *A. melas* as *A. gambiae melas.*

The work of Ribbands (1944) and Thomson (1945–47–48) has contributed very essentially to our present knowledge of the bionomics of *A. gambiae melas* which can be summarized as follows:

A. gambiae melas shows a distinct preference for breeding in salt water along the lagoons and tidal swamps of the West African coast where its geographical distribution overlaps with that of *A. gambiae gambiae* to a high degree. However, about one mile from the shore *A. gambiae gambiae* becomes the predominant, if not the only species.

As mentioned before, the breeding places of *A. gambiae melas* are almost entirely confined to parts of the coastal swamps flooded by high spring tides and characterized by the presence of *Avicennia* mangroves and by wide stretches of *Paspalum vaginatum*. *A. gambiae melas* can breed in water containing up to 47.6 gm. of sodium chloride per litre, which equals 150% concentration of sea-water in the

Bight of Guinea. The composition of the local population of the *A. gambiae* group varies according to the distance from the sea, to the topography of the area and also to the season of the year. While the peak of production of *A. gambiae gambiae* is related mainly to the rainfall, the peak density of *A. gambiae melas* is related to the tidal movements particularly during the dry season (Freetown, Sierra Leone). However, in areas where the tide range is small and the tidal movements not regular (Lagos), this relation is much less obvious.

More recent researches of Thomson's (1948) refer to the behaviour of *A. gambiae melas* and tend to stress the differences in the bionomics of the two components of the *A. gambiae* group. The indoor biting activity of *A. gambiae melas* is similar to that of *A. gambiae gambiae*: both show a marked increase after midnight and the peak of the biting cycle occurs between 04.00 hours and dawn. Both *A. gambiae gambiae* and *A. gambiae melas* show a tendency to leave the human habitations at dawn and to make use of outdoor shelters (overhanging earthbanks, ant-hills) but the latter mosquito is found in outdoor shelters much more often. There is some evidence that *A. gambiae melas* is less strictly anthropophilic than *A. gambiae gambiae* and that goats, pigs, and cows may attract it almost as much as man.

The investigation of the comparative infectivity of both *A. gambiae gambiae* and *A. gambiae melas* is based on identification of females from which egg batches have been obtained and examined prior to dissection of adults. This laborious method has shown that under equal conditions for acquiring an infection with *P. falciparum, A. gambiae melas* seems to be a less efficient vector than *A. gambiae gambiae*. (Thomson 1947.) This finding has recently (1948) been corroborated since it was found that in Lagos during 1947 the overall infectivity rate of salivary glands of *A. gambiae gambiae* was 11.2 or about 40% higher than the corresponding rate for *A. gambiae melas* (7.2 per cent).

This observation combined with dissimilar trends of the seasonal natural infectivity of both mosquitoes suggests that there may be some still unknown differences in their behaviour. However, there is little doubt that *A. gambiae melas*, whatever its taxonomic status may be, is a formidable vector of human malaria along the coast of West Africa.

5. Principles of Drainage

These have not been very different from the methods of swamp drainage first used by Sir Malcolm Watson on Carey Island in Malaya forty years ago. The rationale of the method is well described by Herms and Gray (1941) who classify it as a reclamation type of drainage of salt water swamps. It consists of (a) building a seawall (also known as bund or dyke) which encloses the low-lying swamp and prevents the tidal waters from flooding it, (b) collecting the water in the swamp in a system of channels which lead to (c) a controlled outlet in the form of a sluice gate. The sluice gate open at the low tide permits the outflow of water from the system of drains into the creek. The gate is closed at the high tide and prevents the inflow of water when the water level outside the dyke is higher than the water level inside it.

A detailed description of the technical side of the Lagos swamp drainage scheme will be found in Gilroy's outstanding monograph (1948). However a brief summary of it will give an idea of the type of work accomplished with great success.

Although the principle of the reclamation type of swamp drainage is well known, its adaptation to the small tidal range in Lagos was novel, since one disposed of only a small waterhead to run off the impounded water from the flat swampland to the creek.

The bund built of peaty soil excavated from the facade drain follows the line of the foreshore and is set about 50 ft. inland from it. Its height is such that it will prevent even the highest spring tides from passing over. It has a top width of 6 ft. and a protective berm on the seaward side to reduce the effect of sea-erosion.

Concrete, hand-operated sluice gate.

Sluice gate, the bund and the facade drain. Note behind the sluice gate the palm-thatched hut of the operator and the palm-trunk bridge.

The system of inland channels depends entirely on the topography of the area. As a general rule the facade drain is connected with the contour or hill-side drain dug round the inland limit of the swamp. All isolated higher levels are also provided with contour drains and the vast stretches of Paspalum grass are drained by small herring-bone or separate drains.

The land in the *Rhizophora* and *Avicennia* zone has a fairly uniform level and no gradient needs to be given to the channels which are excavated to a uniform depth of 4 feet, viz. about 9 ins. below the lowest level of the run-off. They always contain water and have clean edges and suitably sloped walls. Three types of drainage pattern have been used; (a) complete

drainage with the object of controlling breeding in the shortest possible time, (b) minimal drainage, where main drain can be left to gradually dry out the bunded swamp and (c) preliminary drainage carried out as an immediate expediency until the swamp floor has partly dried and hardened (Gilroy 1948). The possibility of designing a system of drains without any gradient greatly facilitated the task and permitted the use of unskilled manual labour on a large scale. The tendency towards the minimal drainage greatly increased the speed of work.

Four types of drains were used: (a) the facade drain (10 ft. invert) from which the spoil provides material for the building of the parallel bund, (b) main drains (7 ft. invert) which lead the internal system of channels towards the sluice gate, (c) subsidiary drains which drain the low-lying ponds into the nearby main channels and (d) contour drains which are really small scale foot-hill drains since they follow the margin between swamp and high land. The bottom width of the two last mentioned drains is 3′ 6″.

The concrete hand-operated sluices are of an original design based on an approximate estimate of 1 foot of width of sluice to every 40 acres of swamp. The most important feature of the sluice—the height of the sill in relation to the tides—is set at about 3 feet below the level of the lowest recorded tide.

The operation of the drainage system is carried out throughout the year and varies slightly according to the season. During the rainy season the sluice is opened twice daily at every low tide and even after a heavy storm the water accumulated in the system of drains can be easily led off within a few hours. During the dry season from October to December tides often do not fall to the usual level for days and the regular rhythm of opening the sluice gates cannot always be kept up. This variation of tide ranges and times is quite unpredictable in a maze of creeks surrounding the swamps and must be judged by the sluice gate operators.

The extent of the Lagos scheme can be seen from the following data. Lagos has a population of about 200,000 Africans and several thousands of Europeans and is a busy colonial port. The urban district of it has an area of 24 square miles, of which about 7½ square miles were mosquito breeding tidal swamps. Since 1943 an average of 1000 acres a year have been drained and the scheme is now completed. Of the remaining 1½ square miles of swamps 1 square mile is being reclaimed by sand filling, ½ square mile of swamp is unsuitable for drainage on account of the limited tidal range and must eventually be dealt with by different methods. The summary of the progress of the scheme is given in the following table.

6. Evaluation of Results

Coastal swamps breeding *A. gambiae melas* cover about ¼ of the total area of the town of Lagos and the control of this mosquito by swamp drainage does not involve dealing with *A. gambiae gambiae* which breeds, as it is well known, in borrow pits, puddles, wells, pools and other rather small collections of water. The control of *A. gambiae gambiae* in Lagos is carried out by the local Health Office, by routine larvicidal methods based on the division of the whole township area into 35 zones, to each of which is as-

TABLE 1. Summary of the Progress of the Lagos Swamp Drainage Scheme.

Year	Area in acres	Length of bund	Length of drains	Number of sluice gates
1943	610	3 miles	16.1 miles	2
1944	1093	6.2 miles	30.7 miles	6
1945	909	8.6 miles	42.1 miles	7
1946	1583	2.9 miles	41.5 miles	5
Total	4195	20.7 miles	130.4 miles	21

signed a permanent oiling team. Each zone is divided into 5 oiling-sectors, each of which represents the daily task of the team.

The entomological section of the Malaria Unit was assigned to collect the data from the whole of the township area. However only the results pertaining to the control of *A. gambiae melas* need to be reported here.

This section was divided into two parts: (a) Adult Capture Service and (b) Larvae Check-Control Service which dealt with the imagines and larvae of the local malaria vectors respectively.

(a) *Adult captures:*

The evaluation of the control of *A. gamgiae melas* was based on a regular weekly collection of adult mosquitoes from 275 selected Capture Stations suitably distributed over the controlled area. These stations are houses inhabited by the African population where on fixed days of the week trained collectors capture all adult mosquitoes found inside the rooms in the early hours of the morning. This is carried out by the "spray-floor sheet" technique based on spraying the rooms with suitably calculated (1 fl. oz. per 1000 cubic feet) amount of 0.1% pyrethrum/kerosene spray and collecting all dead mosquitoes found on a standard size sheet spread on the floor.

Mosquitoes collected from the Capture Stations are identified in the laboratory, dissected for sporozoites in the salivary glands and the results of collections recorded.

The relative numbers of collected malaria vectors are assessed by means of the Average Anopheles Density index (A.A.D.) separately for each zone. The A.A.D. index represents the mean number of female *Anopheles* found in one room of a Capture Station per day. This index calculated for each zone represents the daily mean of all Capture Stations indices within a particular zone during the month.

The effect of swamp drainage on the mosquito density in any coastal zone can be best shown by tabulating the mean and peak figures recorded from two typical zones viz: Apapa and Meridian Point during the period covering the conditions before and after drainage of zonal swamps breeding *A. gambiae melas.*

(b) *Larvae Check Control:*

The amount of anopheline breeding in uncontrolled stretches of swamps and in reclaimed areas was checked over a period of 3 years. Collections of larvae

TABLE 2. Average *Anopheles* density in two typical *A. gambiae melas* breeding areas before and after completion of the drainage scheme.

APAPA	Mean A.A.D. per room	Max. A.A.D. per room	MERIDIAN POINT	Mean A.A.D. per room	Max. A.A.D. per room
1942 Before drainage	47.0	500 ?		—	—
1943 During drainage	12.0	28.5	1944 Before drainage	25.0	41.5
1944 After drainage	3.7	7.2	1945 After drainage	2.8	6.0
1946 III qtr.	1.8	5.7	1946 III qtr.	0.7	3.8
IV "	0.25	0.5	IV "	0.5	0.7
1947 I qtr.	0.2	0.3	1947 I qtr.	0.6	0.9
II "	1.2	1.7	II "	2.1	2.7
III "	2.2	3.8	III "	1.2	2.0
IV "	0.5	0.8	IV "	0.3	0.4

were made systematically at weekly intervals by supervised trained personnel.

The whole area is divided into zones. Each of them has a permanent team, which covers the zone assigned to it within one week, working every day in one of the five sectors into which the zone is divided.

The method of sampling is that of using a close-mesh standard size larval net which is swept at 4" below water level at both edges of drains and along the uncontrolled stretches of swamps. Every 100 feet the net is emptied and rinsed in a dish and the numbers of *Anopheles* larvae and their respective instars recorded.

Owing to the war-time emergency it was not possible to carry out a pre-control larval survey of the drained areas and the figures for comparative pre-and-post control larval densities are not available.

However, two typical coastal salt water swamps, Mekunwen and Victoria which are being slowly filled in by sand-pumping are still in an almost virginal state. They offer an excellent comparative picture of the anopheline breeding activity in a virtually uncontrolled zone.

TABLE 3. Mean number of anopheline larvae collected daily per acre of water-surface in drained and undrained areas in Lagos.

	1946	1947
Drained coastal swamps	11.4	28.4
Undrained coastal swamps (Mekunwen & Victoria)	578.2	1734.8

The use of larval nets swept along the edge of the drains gives also an idea of the anopheline density per one mile of drain. This figure varies according to the season to the width of the drain and to its distance from the sluice gate as shown in the following table, covering the period 1946–1947:

TABLE 4. Mean number of anopheline larvae per 1 mile of drain, 1946–1947.

	Rainy season	Dry season
Main drain	1.2	3.0
Subsidiary drain	7.2	14.6
Contour drain	15.4	68.8

The investigation of the respective percentages of larval instars has revealed that well over 50% of anopheline larvae found in the drains are first or second instars while third and fourth instars of anopheline larvae were much less frequent. Pupae were found infrequently as shown in the following table.

TABLE 5. Respective percentages of various instars of anopheline larvae collected in all drainage channels during 1947.

	Instars I & II	Instars III & IV	Pupae
1st quarter 1947	75	25	0
2nd "	51	48	1
3rd "	50	47	3
4th "	54	44	2.5

The increase of larval breeding and the appearance of pupae in the distant parts of the channel system during the period of high tides about the middle of the dry season can be explained by the decrease of the controlling factor of fluctuating water level combined with the more difficult access of fish to the shallow stagnant drains.

Regular weekly returns of results of routine larval surveys are always of great importance but particularly during this period. Any breeding focus found in the drained area is marked in the field (after being treated). and subsequently plotted on the plan of the respective drainage zone. This permits the detection of any faults in the maintenance of channels.

"A most satisfying experience is to see the sun-cracked dry bottom of a lake that a week before was crossed by a canoe" (Gilroy 1948).

Immediate results of swamp drainage are seen soon after the exclusion of tides from the swamp and consist of quick drying up of the land followed by cracking of the mud which forms the bottom of the swamp floor. This is soon followed by changes in vegetation. Rhizophora mangroves are visibly affected by the new conditions and die out within a year. The growth of Avicennia is not affected nor is Paspalum. New plant life hitherto limited to the higher contours appears within the next two years and soon the whole

vegetation of the drained area shows a striking difference from what it was prior to the exclusion of the tidal waters.

With the rapid exclusion of their usual breeding places the extensive breeding of *A. gambiae melas* disappears completely within a week. The only water that remains on the drained land is the brackish water in the system of drains.

"In the original designing of the Lagos scheme it was taken for granted that *A. gambiae melas* would breed in the drains and that regular larviciding would be required. The possibility or even the certainty of anopheline breeding in drains would not be a valid reason against swamp drainage. In an undrained swamp breeding occurs over many hundreds of acres even though it may be detected and reported only at the margins. On the other hand when the swamp has been controlled all surface water is contained in the channels where it is readily accessible and being free from vegetation it is open to the action of larvicides should they be necessary" Gilroy (1948).

The freedom of well maintained but *otherwise untreated* drains from any significant amount of larval breeding is probably due not to one but to several combined factors. (a) Complete alteration of the breeding habitat by temporary impounding of any available water in relatively deep channels without any marginal vegetation.

(b) Cyclical fluctuation of water level in the channel during the period of discharge through the open sluice gates.

(c) Increased activity of several species of indigenous larvivorous fish which have a free access even to the farthest points of the drainage system during most of the year.

Of several species of small Gobidae, Cichlidae and Cyprinodontidae always present in the drains at least two proved to be very active predators. *Eleotris lebretoni* ("Kusukusu" in Yoruba language) and *Haplochilus spilanchen* ("Majoju") are of very definite larvivorous value as found in experiments carried out in the laboratory and in the field.

The final question arises whether the control of *A. gambiae melas* by swamp drainage was justified from practical point of view since perhaps the same good or even better results could have been achieved by other modern methods of control. The question thus posed does not take into account the value of dewatered land, which can be and has already been used for agricultural purposes and for afforestation but pertains only to the public health point of view.

To answer it we must examine the purely technical aspect of other malaria control measures possible in local conditions. As pointed out by Gilroy (1948) it was found that the use of larvicides in an undrained swamp is time consuming, difficult, expensive and not very effective. Virgin salt-water swamps are inaccessible flats with a soft, muddy soil crisscrossed by numerous small creeks and deeper streams. Exceedingly numerous anopheline breeding foci are irregularly scattered and hidden among the stretches of coarse salt marsh grass which presents a formidable obstacle to the traditional techniques of oiling or dusting with larvicidal dusts.

The use of residual DDT for spraying of houses must be ruled out since there are only few human habitations within or in the vicinity of the main breeding area and spraying of these primitive dwellings would not or very little decrease the anopheline population.

The initial aim of the described method of swamp drainage was simply to canalize an otherwise uncontrollable zone in order to deal with the malaria vector by chemical larvicidal measures. The discovery of the specialized breeding habits of *A. gambiae melas* provided a basis for planning a combined hydrotechnical and naturalistic approach to the problem and offered a possibility of an effective "species control" bordering on local eradication of one of the main malaria vectors.

Bibliography

1. Barber, M. A. and Olinger, M. T. (1931). Studies on malaria in S. Nigeria. Ann. Trop. Med. and Par. 25, 461.

2. BOTHA DE MEILLON. The Anophelini of the Ethiopian Geographical Region. South Afr. Inst. for Med. Res. Johannesburg 1947.
3. CHWATT, L. J. (1945). Studies on the melanic variety of *A. gambiae* in S. Nigeria. Journ. Trop. Med. and Hygiene 48, 22.
4. CHWATT, L. J. (1945). The morphology of the pharyngeal armature in *A. gambiae* and var. *melas* from S. Nigeria. Ann. Trop. Med. and Par. 39, 124.
5. GILROY, A. B. Malaria Control by Coastal Swamp Drainage in W. Africa. Ross Inst. of Trop. Hygiene. London 1948.
6. GILROY, A. B. AND CHWATT, L. J. (1945). Mosquito Control by swamp drainage in the coastal belt of Nigeria. Ann. Trop. Med. and Par. 39, 19.
7. HERMS, W. B. AND GRAY, H. F. Mosquito Control. New York: Commonwealth Fund. London: Humphrey Milford. (1940).
8. RIBBANDS, C. R. (1944). Differences between *A. melas* and *A. gambiae* I. Ann. Trop. Med. and Par. 38, 85.
9. RIBBANDS, C. R. (1944). Differences between *A. melas* and *A. gambiae* II. Ibid. 38, 37.
10. RIBBANDS, C. R. (1944). The influence of rainfall, tides and periodic fluctuations on population of *A. melas*. Bull. Entom. Res. 36, 395.
11. ROSEVEAR, D. R. (1947). Mangrove swamps. Farm and Forest 8, 23.
12. THOMSON, R. C. MUIRHEAD (1945). Studies on the breeding places and control of *A. gambiae* and *A. gambiae* var. *melas* in coastal districts of Sierra Leone. Bull. Entom. Res. 36, 185.
13. THOMSON, R. C. MUIRHEAD. (1948). Studies on *Anopheles gambiae* and *A. melas* in and around Lagos. Bull. Entom. Res. 38, 527.
14. THOMSON, R. C. MUIRHEAD (1947). Recent knowledge about malaria vectors in West Africa. Trans. Roy. Soc. Trop. Med. 40, 511.
15. TREDRE, R. F. (1946). The role of *An. gambiae* var. *melas* in the transmission of malaria in the vicinity of Freetown estuary Sierra-Leone. Ann. Trop. Med. and Par. 40, 380.

OBSERVATIONS ON THE USE OF TOXIC BRIQUETTES FOR MOSQUITO CONTROL

TED G. RALEY
Manager
AND
EDWARD D. DAVIS *
Entomologist, Consolidated Mosquito Abatement District, Fresno County California

While the idea or theory of mosquito control by utilizing fixed dispensers or briquettes impregnated with insecticides is not new, there has been little investigation of this method of mosquito control carried on in the San Joaquin Valley of California. This paper will relate the experiences and observations gathered by the Consolidated Mosquito Abatement District, Fresno County, California, where extensive experimental work was conducted with briquettes for larval control during the 1948 hatching season. Several styles of briquettes were used in the test work; no attempt, however, is made to compare one with the other. Instead, a general discussion relative to work performed with briquettes is set forth.

The desirability for some method of larval control other than spraying, either hand or power, became apparent soon after the formation of the district in 1946. Included in the 1000 square mile area that must be regularly patrolled for mosquito sources are a vast number of small but prolific larval hatching areas that must be constantly watched. Many of these sources take little time to treat for larvae; their great number, however, requires much of the operator's time that could be used to better advantage on larger problems. While many of the sources have been entirely eliminated and others will

* Mr. Davis is now manager of the Fresno Mosquito Abatement District, Fresno, California.

be, there are still numerous ones that must be inspected and treated regularly for effective mosquito control. The larval sources that are troublesome where impregnated briquettes can be used include irrigation standpipes, artificial containers, household drains, reservoirs, dairy drains, etc. Figure 1 shows a household drain being treated by an operator with a power spray rig. As will be noted, this drain is covered with a so-called "lid"; this covering, however, is not tight enough to prevent the entrance of adult mosquitoes. Drains of this type, if not regularly treated, invariably produce large numbers of mosquitoes. Since much of the soil throughout the District is a heavy clay loam, this problem is constant during the active mosquito breeding season.

The prime purpose governing our experiments with briquettes for mosquito control was to find some means of obtaining satisfactory control that would be effective over a long period of time. Several of the new insecticides are highly toxic to mosquito larvae and have good residual properties. Some method of dispensing these materials in proper amounts, at the right time, seemed to be the best approach to the problem at hand. Combining suitable materials to achieve this result presented many difficulties and many combinations of ingredients and methods were tested before satisfactory results were achieved.

In our first trial with dispensers, several important lessons were learned. The original work was done with straight casting plaster and 25% emulsible DDT, putting this mix in a small-mouth coffee jar, letting it become semi-hard, then placing it in the larval source. It was noted, on close observation, that the percentage of kill was less a few feet from the submerged jar than directly over it. Indications pointed to the possibility that DDT was not being released rapidly enough, due to the very slow breakdown of the mixture in the jar. In this particular instance, the water in the larval source was practically motionless. Upon moving the dispenser to another location, within the source, good kills were again registered directly above the dispenser but were not extended over a very wide area. This fact led to our second means of dispensing the toxic agent: namely, the perforated coffee can, shown in Figure 2.

The principle involved in this style of dispenser was to bring the releasing agent in more direct contact with the water, thereby using the water to help break down the material within the can. The mixture used in this dispenser was a casting plaster, sawdust, and DDT-gamma BHC combination, formed into a briquette and placed in the can. By using the can or container to surround the toxic agent, it not only protects the briquette from being coated with suspended solids, but it also gives reasonable protection in the event animals or children get curious. This dispenser was found to be very useful where situations necessitated the toxic agent being carried out into a pond or stream. By placing several of these at or near the incoming water, the water would force the material through the holes in the can and carry it over a wide area. Further experiments indicated that if the briquette, without the guard, was used in similar situations, the washing would dissolve the material at such a rapid rate that only short period control was accomplished. One fault with the can dispenser, observation revealed, is the plugging of the holes when it is used in sources containing heavy organic matter.

From experience gained in working with the briquette of sawdust, casting plaster, and insecticides, it was found that if the guard was eliminated the breakdown would be sufficient to give satisfactory control in quiet water. The briquette suspended on wire, (Fig. 2) is composed of the same mixture as was utilized in the can. As shown in Fig. 2, the briquette on extreme left is the original size, 3½ inches wide, 3 inches thick. The briquette second from left gave effectual control for a 3½-month period and, as will be noted, has dissolved to about one-fourth its origi-

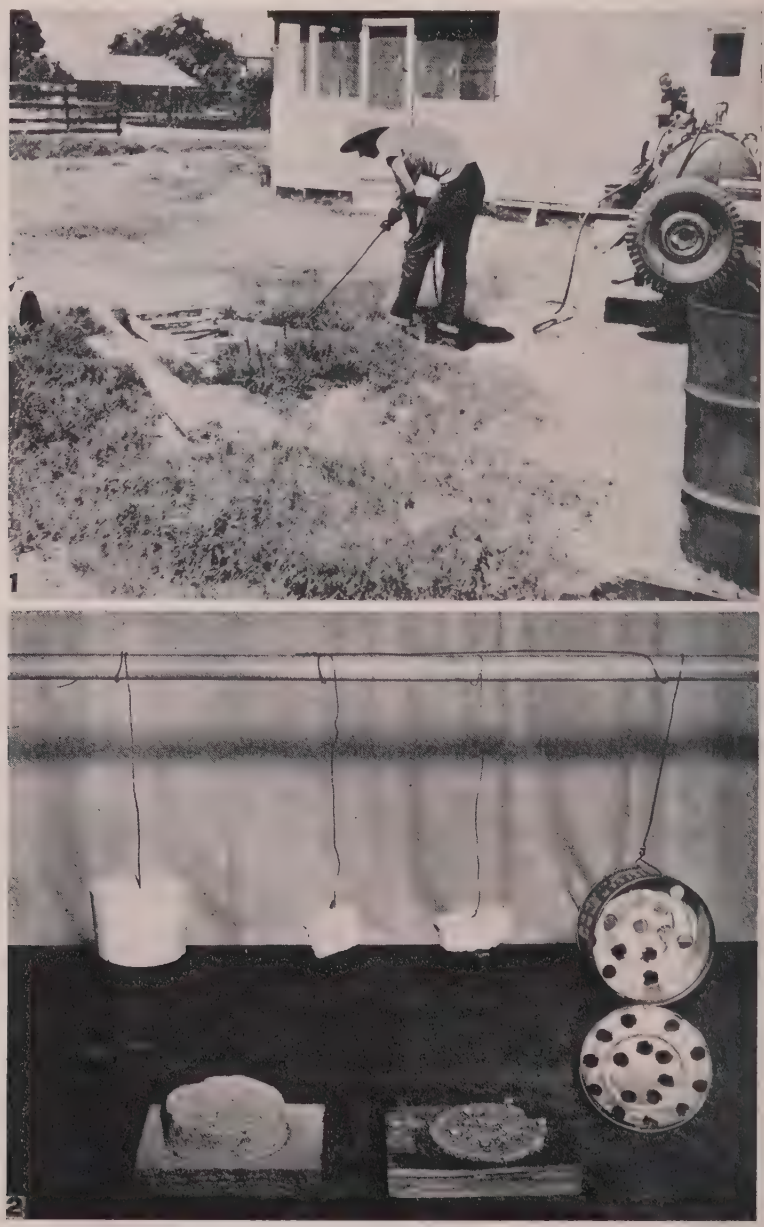

FIG. 1. Spraying household drain with power spray rig.
FIG. 2. Briquettes before and after use.

nal size. This dispenser was in a very prolific mosquito source that had required treating at least every seven days. After the briquette was placed in this source, no further treatment was necessary. The briquette third from left gave very effective control for three months in a heavily producing mosquito source; as shown in Figure 2, however, the bottom half is the only part that shows much dissolution, due to the fluctuation of the water level within the source. If placed in a more or less permanent position within the source, any fluctuation of the water may defeat the purpose of a fixed dispenser. In several instances the water level dropped below the briquette, and larvae were observed a few days later. To correct this condition, the briquette molded on the wooden block (foreground, Fig. 2) was prepared.

By substituting the wood float for the wire, the briquette will fluctuate with the water. The briquette with float (Fig. 2, foreground left) in its original size, is 4 inches in diameter, 1½ inches in thickness. The float briquette on right (Fig. 2, foreground) gave effective control for a three-month period, and as shown, has worn to a thickness of one-fourth inch. The control obtained in the situation where this particular float was used definitely demonstrated the merits of utilizing briquettes for mosquito control. The source area was approximately 16 square feet with dense weed growth and debris. Upon initially placing the float, it was thought, due to the surface obstruction, not enough toxic agent would be released for effective control. Since the float was able to move about in the pond, however, the material was released over the entire area. This advantage was not possible where the briquette suspended on wire was used. If the movement of water in the larvae source is quite active, and control is attempted by this means, the float should be limited in its ability to move about by some restriction, possibly an anchor. This will prevent the float from becoming lodged and losing its full effectiveness.

The construction of the several briquettes mentioned in this paper is simple, and they can be prepared without skilled labor or elaborate equipment. In mixing the various briquettes described, equal parts of casting plaster and shavings were used. This, of course, can be varied depending on the speed of breakdown desired. The size of the briquette can be determined by the use for which it is intended. The toxic agents used in most of the work are standard insecticides, DDT and gamma isomer of BHC. Other materials were tried, such as Parathion, Dianisyl Trichlorethane, DDD, but at this time insufficient work has been done with these chemicals impregnated into briquettes to make possible and recommendations as to their effectiveness.

In the wire-suspended briquette and wood-float briquette, forms were used to obtain the final shape. After mixing the plaster, wood shavings, DDT and gamma BHC together, the water is added to make a putty-like mixture, which is poured into the mold for hardening. The float briquette is prepared by fixing several large-headed tacks or screws into a block of wood, placing a mold around these, and adding the mixture for hardening. In every case, except the glass jar used in the first experiment, the same mixture was utilized. The formula of this is given below:

200 grams casting plaster
1 cup wood shavings
20 grams gamma isomer (Isotox), 25% W/P
50 grams DDT (50% W/P)
200 CC H_2O

The formula will, of course, vary with the work to be performed or type of briquette desired, and the one given above is intended only as a guide.

From the information gathered during the 1948 mosquito season relative to the use of briquettes for mosquito control, extensive use will be made of this method in many parts of this District.

A NOTE ON DISEASE-BEARING MOSQUITOES BREEDING IN BROMELIADS*

WILLIAM H. W. KOMP
Laboratory of Tropical Diseases, Microbiological Institute, National Institutes of Health
Bethesda, Md.

The article by Leon Dalencour in the September 1948 number of "Mosquito News," concerning the breeding of mosquitoes (species not mentioned) in bromeliads, which he had observed in Haiti, has prompted the writer to submit the following notes. During his tour of duty in the Panama Canal Zone, he collected on several occasions and in several localities, both in the Panama Canal Zone and in the Republic of Panama, larvae and pupae of *Haemagogus argyromeris* Dyar and Ludlow, from the water in the leaf-bases of a terrestrial bromeliad, *Bromelia pinguin L.* On one occasion a single larva of the same species was found in an arboreal bromeliad, *Gravisia* sp., at El Valle de Anton, in Panama.

The interest attached to these findings is that various species of *Haemagogus* are known to be the vectors of "jungle" or sylvatic yellow fever in Colombia and Brazil. *H. argyromeris* departs from the usual habit of the other species of the genus in that it does not confine itself to tree-holes, bamboo, etc., for its breeding places, but can also be found in rock-pools, tin cans, and rarely in ground pools. The writer believes that the present records are the first published of any species of *Haemagogus* breeding in water contained in a living plant.

Bromelia pinguin is quite common in various parts of Panama, and is extensively planted on newly made road embankments to prevent cattle from trampling them before they have reached their angle of repose. *Should an outbreak of yellow fever ever occur again in Panama, attention will have to be given to such breeding places of Haemagogus.*

On another occasion, intensive breeding of several as yet unidentified species of sabethine mosquitoes was found in the water in another species of terrestrial bromeliad, *B. humilis,* at Puerto de la Cruz, northwest of Barcelona, on the arid north coast of Venezuela. At the same time, two female specimens of what is probably *Haemagogus uriartei* Shannon and Del Ponte were taken. These were undoubtedly breeding in the water in these bromeliads, as it was dry season, and the area was dry and dusty. All tree-holes and similar normal breeding places of *Haemagogus* were without water.

* *Editor's Note:* In the fall of 1948, Dr. Komp called attention to the facts discussed in this article. The italicized sentence in the third paragraph proved to be prophetic: an outbreak of yellow fever *did occur,* as described by Dr. Bishopp in the accompanying note.

YELLOW FEVER IN PANAMA

A minor outbreak of yellow fever near Pacora in the Republic of Panama was reported on November 11, 1948. This was the first occurrence of the disease in that country since 1905. Five fatal cases were recorded between November 11 and December 28, 1948. The outbreak was terminated through the prompt vaccination of a large percentage of the people in that area. A quarter of a million doses of yellow fever vaccine, prepared at the Rocky Mountain spotted fever laboratory in Montana were promptly provided. This was the jungle type of yellow fever and was probably transmitted by *Haemagogus spegazzini* Brethes.

F. C. BISHOPP

NEWS AND NOTES

C. Y. Chow, an AMCA member and contributor, has written to several of us from China. His address is: "Taiwan Malaria Research Institute, P. O. Box 182, Taipeh, Taiwan." It is of interest to note that an airmail letter from Taiwan (Formosa) costs as much as 1/20 of Dr. Chow's monthly salary. He had to leave his library in Nanking when he departed by plane, so he will welcome any reprints which AMCA members send him. Excerpts from his letter, dated March 26, follow:

"From Caracas I went down to Maracay, i.e. to Dr. Gabaldon's laboratory. They have been doing very good work on big scale malaria control—using both engineering and DDT spraying methods. After staying one week, I flew over to Bogotá, Colombia. Dr. Marston Bates' laboratory is situated at Villavicencio, a small town about one hour's flying from Bogotá. I worked with him on the chemical contents of water in relation to the egg laying habit of *Anopheles darlingi,* the chief malaria vector of his place. * * * In Los Angeles, I visited Hollywood, but did not see any actors or actresses. A couple of days were spent in Professor Herms' lab at Berkeley, and the U. S. P. H. S. Plague lab at San Francisco. On August 31, I took SS President Cleveland to sail to China. I arrived in Shanghai in the middle of last September. Unfortunately, because of the war, we moved our lab from Nanking to Taiwan last December. We have several field stations on this island. * * * In north Taiwan we use the automatic siphon gates to control *A. minimus.* In the south, we use both DDT larvicide and adulticide for controlling *A. hyrcanus sinensis.* We use a local product, Camphor oil, as solvent for DDT emulsion. We test DDT residual spraying on 100 mg. per sq. ft. Also, continuing on the test of Paludrine and Hetrazan for oriental peoples. * * * With best wishes to all of you."

Sincerely,
C. Y. Chow

Information has just been received, as we go to press, that Dr. W. B. Herms, of Berkeley, California, died suddenly May 9, of a heart attack. This is a great loss, both to those who respected Dr. Herms as a scientist and to those who loved him as a teacher and fine man. The sympathy of the entire American Mosquito Control Association is extended to Mrs. Herms and other members of his family. H. L. T.

Mr. W. H. W. Komp left May 4 for Guatemala, where he expects to remain for about one month before going to British Honduras. There he will stay for another month with Belize Estates Co., Ltd., at Belize; and from there he will return to Guatemala for a short period. He hopes to be back at the National Institutes of Health in Bethesda by August 1. His address is c/o Major C. G. Dobrovolny, Oficina Sanitaria Panamericana, Apartado No. 383, Guatemala. His project, as usual, will be the hunting of mosquitoes and appraisal of the malaria situations.

Ralph J. VanDerwerker, Chief Sanitary Engineer with the Pan American Sanitary Bureau, has written the following from São Paulo, Brazil, under date of March 27:

"This trip is one of my most interesting journeys up to the present time and I find it very enjoyable.

"Dr. A. Ayroza Galvão took me up to Araraguara yesterday where he is connected with a demonstration health center. He is in charge of their malaria control work.

"This malaria program involves spraying approximately 2500 rural homes with DDT emulsion spray 2 or 3 times a year in the malarious areas. *A. darlingi* is their most feared vector and, as you know, has most irregular outbreaks. So far in 2 years of the work, no new infections have developed but they are waiting to see if it is a lull in prevalence of *darlingi* or the DDT before predicting that the problem is solved.

"The State of São Paulo is treating about 30,000 rural homes in malarious areas with the same results. They, too, are cautious about predictions but feel very happy and pleased with the results so far.

"The National Malaria Service of Brazil in 1948 applied 1,000,000 treatments and hope to triple that in 1949. Dr. Pinotti, chief of this service, is very enthusiastic about the results and feels that this is the answer to stopping malaria. They have an emulsion mixing plant producing 2000 gals./hr. to supply their crews."

Dr. F. C. Bishopp attended the National Agricultural Aviation Conference held April 21 and 22 in Kansas City, Missouri; and he spoke on, "Aircraft in the war against insects." Dr. Bishopp says that mosquitoes received some attention at these meetings, but that the main consideration was of strictly agricultural uses, such as crop treatment with insecticides, fungicides, weed killers, hormones, and fertilizers, also seeding crop transport, etc. H. L. T.

PYRETHRIN-LIKE MATERIAL SYNTHESIZED. The war on mosquitoes will be aided by the synthesis in the chemical laboratories of the Bureau of Entomology and Plant Quarantine at Beltsville, Md. of potent insecticides almost identical with pyrethrins derived from plants.

This discovery announced by the U. S. Department of Agriculture in March 1949 was the culmination of 18 years of intensive investigations of pyrethrum by Dr. F. B. LaForge. He found several insecticidal elements to occur in pyrethrum flowers in addition to pyrethrins I and II. The true chemical make-up of the

pyrethrins was determined, and finally Schechter, LaForge and Green devised a way of making in the laboratory compounds very similar to the pyrethrins.

One of these compounds tested against house flies by W. A. Gersdorff was found to be about six times as toxic as pyrethrum extract. It is more stable than the pyrethrins and will probbly have the same low toxicity to higher animals. The material is still in an early experimental stage but industry is much interested in it and there appears to be no reason why it should not be available for commercial use in about a year.

Details of the method of synthesis are soon to be published in the Journal of the American Chemical Society. F. C. BISHOPP

A banquet climaxing the 3-day Annual Convention of the N. J. Mosquito Extermination Association in Atlantic City, was held Thursday night, March 24, and approximately 110 persons attended. Members were on hand from all over the United States. They heard Harold F. Gray, President of the AMCA pay tribute to the industry and loyalty of Dr. Robert D. Glasgow, retiring Editor-in-Chief of "Mosquito News." They watched as Mr. Gray, on behalf of the AMCA, presented Dr. Glasgow with an appropriately-inscribed Elgin watch in a velvet case. They listened intently as Dr. Glasgow accepted the gift and replied in his quietly modest way. It was a memorable occasion, full of meaning for the good Doctor's friends and co-workers. Tommy Mulhern's camera recorded some of the action; the accompanying picture shows Dr. Glasgow receiving the watch and hearty congratulations from President Gray.

H. L. T.

Harry Stage, Assistant Chief, Division of Insects Affecting Man and Animals, USDA, is preparing—as this issue goes to press—to spend approximately 2 months in Africa, British East and West, enjoying a few days in London en route. He will travel under the auspices of the Economic Cooperative Administration, and will critically review certain research now under way on malaria and trypanosomiasis. The date of departure, about May 1; return, perhaps July 1, 1949. Lucky Africans! H. L. T.

It is another Spring, and another one of AMCA'S fairer members has decided to promenade down that middle-aisle. Louise Goode, my erstwhile associate in the laboratory at Bethesda, who has contributed abstracts to "Mosquito News," assisted at meetings, and appeared in one of the photographs in the December number of the "News," plans to become Mrs. John Scoggins on June 11. The place, her home, Blacksburg, S. C. Dry those tears boys, and congratulate the groom and wish Louise the best of everything for the future. H. L. T.

MAYOR DOROTHY MCCULLOUGH LEE HONORED. The many mosquito fighters who had the pleasure

of meeting Mrs. Dorothy McCullough Lee and hearing her address at mosquito meetings in the last few years were pleased to learn that the Women's National Press Club has chosen her as one of seven to receive from President Truman on May 14, 1949, the Club's annual award to outstanding women of the Country.

Without doubt her effective campaign against mosquitoes led to her election as Commissioner of Public Utilities in Portland, Oregon, a few years ago and last year to her election as mayor, the first woman to become head of a city with a population of over a half million. Our congratulations, Mayor Dorothy McCullough Lee.

F. C. BISHOPP

SOUTH JEFFERSON COUNTY, TEXAS, JOINS THE RAPIDLY GROWING RANKS OF MOSQUITO ABATEMENT DISTRICTS. At the invitation of the South Jefferson County, Texas, Mosquito Control Committee, Thomas D. Mulhern, of New Brunswick, N. J., secretary of the American Mosquito Control Committee, made a five-day mosquito survey of this county in April.

Mulhern, employed by the New Jersey Agricultural Experiment Station at Rutgers University, made a tentative report at the conclusion of his survey of the Gulf Coast County but will make a more detailed and comprehensive report after analyzing and studying all the data and information he assimilated. He emphasized that the mosquito problem facing Jefferson County is in many respects almost an exact duplicate of that which New Jersey has so adequately dealt with during the last forty years. The salt marsh mosquito is the crux of the problem both in New Jersey and in the Jefferson County region, with house mosquitoes also contributing to the annoyance. The extensive rice fields in the area are at times an additional source of mosquitoes of a different type.

The mosquito nuisance, long a plague in Jefferson County, has been reluctantly endured to the point where citizens had almost given it up as a "necessary evil." Taking the lead in a movement to do something decisive about the vexatious problem, the Port Arthur Chamber of Commerce Public Health Committee, Dr. Paul Meyer, chairman, decided that action was imperative.

Meetings and conferences were held. Help of the Navy was secured in demonstrating the effectiveness of DDT airplane spraying. County and city officials cooperated with DDT spraying of ditches and low-lying areas. Temporary comfort resulted from the reduction of pest mosquitoes.

Thus encouraged, the Chamber Health Committee broadened its scope of activities into formation of a South County Mosquito Control Committee. Dr. Meyer was also elected chairman of this group. A campaign to solicit voluntary contributions for a mosquito-control fund was initiated and Roy Harrington, secretary of the local Oil Workers Union, was chairman of the drive for funds.

Primary objective of the funding campaign was to finance the salary and expenses of a mosquito-control manager for the county for two years, while surveys were being made and the program was beginning. All money donated which exceeded $10,000, was to be used to finance actual mosquito-control measures to be recommended by the manager.

Cooperation of civic clubs was corralled and the campaign was geared for action. Preceded by avalanches of radio and newspaper publicity, solicitors made house-to-house contacts in Port Arthur for contributions. A minimum of $5.00 per family unit was requested. Similar campaigns were conducted in neighboring communities near Port Arthur. Over $10,000 was collected.

What next? State legislators from this region suggested introduction of a bill proposing creation of a mosquito-control district for Jefferson County. While studying the proposition, local mosquito-control officials wrote reams of information-inquiring letters to cities, counties and states asking how they had proceeded against mosquitoes. It was during this phase of the project that Mr. Mulhern was consulted. His helpful replies, as well as those from Florida and California mosquito districts, convinced the committee that the only solution to financing a broad and effective mosquito program was through formation of a tax-supported mosquito control district. The bill proposing creation of a Jefferson County mosquito district was duly introduced in the Texas Legislature and passed without a dissenting vote. It was amended to give other counties local option to also form mosquito-control districts.

The bill provides a tax not to exceed 5 cents on a $100 valuation. Before becoming county law, the bill stipulates that a majority of the county voters, all county tax paying voters must also ballot in favor of it. The county court, which will be in charge of forming the mosquito district, plans to submit to the voters the question of creation of a county mosquito district on May 21.

To say that local backers of the bill wish for passage of the legislation is an understatement. The problem of combating mosquitoes in Jefferson County hangs in the balance on the balloting on the county mosquito control bill.

Mulhern appeared optimistic over possibilities of reducing the county mosquito menace providing the program is launched on a broad and well conceived plan.

During his five-day survey of this region, he made aerial and ground inspections, and conferred with county drainage and agricultural officials, who furnished a tremendous amount of valuable information, and the U. S. Public Health Service has since furnished him with accurate sample counts of mosquitoes taken in Beaumont, Port Acres, Port Arthur and Orangefield during the past several years, in cooperation with the Texas State Health Department.

Speaking tentatively of survey results, Mulhern pointed out that the initial problem is to get rid of standing water, and marsh ditching for

drainage or circulation of tide water appears to be the permanent improvements indicated.

Control work should be aimed at immediate relief by temporary means, but at the same time, the program should take into account permanent preventive measures that will eventually decrease the amount of temporary relief work necessary, he said.

Best possible control for the salt marsh mosquito will probably be by providing circulation of marsh water in order that minnows be allowed free access to pools, since they eat the mosquito larvae and thus are a potent control measure in themselves. Such control measures are relatively simple where tide fluctuations are greatest, he said. In the Gulf area, tidal fluctuations are not large and therefore considerable carefully planned ditching work would be necessary.

These opinions were tentative, Mulhern stated, and they will be outlined in detail in a compilation and study of all the data he garnered on his survey of the entire county.

When installed, the program will be under the jurisdiction of the Jefferson County Court: including James Kirkland, County Judge and Commissioners—Gail Hatch, T. B. Ellison, Dick Scurlock and Frank Helmke.

Members of Port Arthur, Texas, City Commission are cooperating, including Dr. James W. Long, Mayor and Commissioners—J. E. Pullen, Al Jenkins, J. P. Logan, Howard Carter, H. A. Tanner and Dan Johnson.

PORT ARTHUR CHAMBER OF COMMERCE,
Port Arthur, Texas

AL TIEMPO QUE LA MALARIA DISMINUYE LA DIVISIÓN DE MALARIOLOGÍA AUMENTA.—Aunque esta noticia parezca paradójica, lo cierto es que la Div. de Malariología, de Venezuela, dependencia que desde 1936 se ocupaba únicamente de todos los problemas relacionados con la malaria. Debido al fuerte descenso que ha sufrido la enfermedad en los últimos dos años y a la introducción del DDT como arma de lucha contra los anofeles y otros artrópodos ha sido encargada de otras actividades sanitarias tales como la represión de huéspedes de enfermedades metaxénicas y en consecuencia de ahora en adelante tendrá que combatir también los trasmisores de fiebre amarilla, enfermedad de chagas y controlar roedores y otras alimañas. Por este motivo el edificio que alberga sus oficinas y laboratorios centrales en Maracay, Edo. Aragua está siendo ampliado como lo muestra la foto.

Even if this news sounds peculiar, the fact is that the Division of Malariology of Venezuela in charge of malaria problems since 1936, owing to the vertical decrease of these problems and the appearance of DDT in the field of sanitation, will have from now on the control of insect carriers of other diseases such as yellow fever mosquitoes. A rodent control program will also be carried out. In order to furnish room for the new activities, the headquarters building in Maracay, Aragua, is being enlarged.

FÍN DEL V CURSO INTERNACIONAL DE MALARIOLOGÍA.—El 18 de Diciembre del año pasado se dió termino al V Curso Internacional de Malariología ofrecido para Médicos e Ingenieros por la División de Malariología, Dirección de Salubridad Pública del Ministerio de Sanidad y Asistencia Social en su sede, la ciudad de Maracay, 100 kilómetros al Oeste de Caracas.

Este Curso dirigido por el Dr. Arnoldo Gabaldon, Jefe de la nombrada División de Malariología, tiene una duración de cuatro meses y medio y consta de una etapa teórico-práctica en las aulas y laboratorios del Edificio Central de la División y una segunda etapa de entrenamiento práctico durante los dos últimos meses que se dedican a trabajos de campo llevados a cabo en las diferentes dependencias de la División, diseminadas en todo el país.

Las materias y profesores para este Curso fueron los siguientes:

Hematología, Dr. Antonio Gómez Marcano; Entomología, Dr. Pablo Cova Garcia; Protozoología, Dr. Arnoldo Gabaldon y Sr. José Antonio López, Anatomía Patológica, Dr. Antonio Gómez Marcano; Sintomatología de la Malaria, Dr. Carlos Zozaya; Terapéutica de la Malaria, Dr. Antonio Gómez Marcano; Epidemiología de la Malaria, Dr. Arnoldo Gabaldon; Ingeniería Antimalárica, Dr. Arturo Luis Berti; Dr. Salvador José Carrillo, Dr. John Maier, Dr. Domenico Filippone; Organización Antimalárica, Dr. Arnoldo Gabaldon, Dr. Antonio Gómez Marcano y Dr. Arturo Luis Berti; Legislación Antimalárica, Dr. Pablo Cova Garcia y Enfermedades Metaxénicas, Dr. Carlos Zozaya.

Dos nuevas materias, Anatomía Patológica y Enfermedades Metaxénicas fueron introducidas para este V Curso al q. asistieron los siguientes estudiantes:

Virgilio Polastri de Ecuador; J. Víctor Avila R., de Guatemala; Gustavo Garcia, de México; José Leão Costa, de Brasil; Alejandro Robleto Pérez, de Nicaragua; Julio Heriberto Torres, de Bolivia; Jorge Salinas Cáceres, de Perú; Aurelio Antonio López, de Panamá; Víctor Lara Ponce, de Bolivia; Julián . Adalberto Rodriguez, de El Salvador; Angelo Cozzani, de Italia y Rubén Henríquez Garcia, Ismael Silva Landaeta, Eladio Russián Vasquez y Ezequiel Sutil O., de Venezuela.

ARTURO LUIS BERTI, Maracay, Venezuela

The fifth International Malaria Course given by the Malaria Division, Direction of Public Health, Ministry of Health, at Maracay, 100 kilometers west from Caracas, ended on December 18, 1948.

This course, directed by Doctor Arnoldo Gabaldon, Chief of said Division, lasted 18 weeks. The first 10 weeks were devoted to lectures and laboratory; the last 8 weeks to field work on different malaria stations and projects conducted by the Division throughout the country.

Subjects and professors were as follows:

Hematology, Dr. Antonio Gómez Marcano; Entomology, Dr. Pablo Cova Garcia; Protozoology, Dr. Arnoldo Gabaldon and Mr. José Antonio López; Malaria Pathology, Dr. Antonio Gómez Marcano; Malaria Symptomatology, Dr. Carlos Zozaya; Malaria Therapeutics, Dr. Antonio Gómez Marcano; Malaria Epidemiology, Dr. Arnoldo Gabaldon; Antimalaria Engineering, Doctors Arturo Luis Berti, Salvador José Carrillo, John Maier and Domenico Filippone; Antimalaria Organization, Doctors Arnoldo Gabaldon, Antonio Gómez Marcano y Arturo Luis Berti; Antimalaria Legislation, Dr. Pablo Cova Garcia; Metaxenic Diseases, Dr. Carlos Zozaya.

Two new subjects, Malaria Pathology and Metaxenic Diseases were introduced on this fifth course.

The following students attended the course: Virgilio Polastri, Ecuador; J. Víctor Avila R., Guatemala; Gustavo Garcia, México; José Leäo Costa, Brasil; Alejandro Robleto Pérez, Nicaragua; Julio Heriberto Torres, Bolivia; Jorge Salinas Cáceres, Perú; Aurelio Antonio López, Panamá; Víctor Lora Ponce, Bolivia; Julián Adalberto Rodriguez, El Salvador; Angelo Cozzani, Italia; Ruben Henríquez Garcia, Ismael Silva Landaeta, Eladio Russián Vázquez, and Ezequiel R. Sutil O, Venezuela.

ARTURO LUIS BERTI, Maracay, Venezuela

Professors (seated) l. to r.: J. A. López, A. L. Berti, S. Carrillo, A. Gabaldon, J. Maier, P. Cova García, C. Zozaya. Background: students.

CORRECTION

In the paper on "The Operation and Physical Evaluation of Routine Applications of DDT Larvicides by Airplane" by H. Stierli and W. R. Schmitz in the March 1949 (Vol. 9 No. 1) issue of MOSQUITO NEWS, the legends of Figure 1 and Figure 2 on page 3 were transposed. The legend under Figure 1 as printed should appear under Figure 2, and the legend under Figure 2 as printed should appear under Figure 1.

ASSOCIATION NEWS

THE 1949 AMCA MEETINGS IN CALIFORNIA

All who attended the AMCA and California M.C.A. meetings in February have reported that they were outstanding in every way. A number of very significant and timely papers were read, and the inspection trips and entertainment features were also especially noteworthy.

Although the reports of the business meetings were not in the hands of the editor in time to be edited for the June issue, the manuscripts of several of the papers presented were received in time for publication. Those published in this issue are as follows:

"Mosquitoes and Mosquito Control in Canada," by Dr. C. R. Twinn, and "*Anopheles gambiae melas* Control by Swamp Drainage in a Coastal Zone of Nigeria," by Dr. L. J. Chwatt.

It is expected that the business transacted at the California meetings and at the meeting of the Interim National Board held at Atlantic City on March 23 will be summarized in the next issue of the News.

SECOND REPORT OF THE AMCA GOOD NEIGHBOR CLUB

The following members of AMCA have contributed to the Good Neighbor Club in amount of $36.00 since our first report which appeared in the June 1948 issue of Mosquito News:

J. B. Gahan	B. V. Travis
Ralph Van Derwerker	Harold Gray
A. W. Lindquist	Rowland Dorer
Andy Roth	Lester Smith
T. D. Mulhern	Perry Ruth
Robert Vannote	C. M. Gjullin
W. W. Yates	Don Rees

Of these J. B. Gahan, B. V. Travis, Harold Gray, Don Rees, and Rowland Dorer contributed $5.00 each.

With this money we have purchased 14 volumes, 56 numbers, of Mosquito News and have forwarded them to the following foreign libraries.

Science Library, Science Museum, South Kensington, London S W 7, England.

University of Panjale, Lahore, Panjale, Pakistan.

Det Laegevidenskabelige, Fakultet, Kjohenhauns, Universitet Copenhagen, Denmark.

Library, South African Institute for Medical Research, P. O. Box 1038, Johannesburg, Union of South Africa.

U. S. Information Center, Kaerntnerstrasse 38, Vienna 1, Austria.

Doyen de la Faculte de Medécine, Université de Liège, Belgium.

A.B.C. Committee, National Library, Athens, Greece.

These volumes have been forwarded at no expense to the Association save for transportation charges from New Brunswick, New Jersey to Washington, D. C. Postage from Washington is furnished gratis by the International Exchange Service.

Won't you join us? Your contributions will be used to purchase additional numbers of Mosquito News for foreign libraries, some of which were destroyed by the recent war.

H. H. STAGE, *Chairman*
Good Neighbor Club

EDITORIAL SECTION

THE PSYCHOLOGICAL EFFECT OF DDT IN THE MOSQUITO CONTROL PROGRAM

Hasta 1943 los métodos de ingeniería habián demostrado su utilidad, usos y limitaciones y sólo deficiencias administrativas y escaceces económicas impedían su aplicación. En ese año la aparición de DDT marcó una etapa de considerable importancia cuya trascendencia aún no estimamos en todo su valer. El DDT vino, no a subtituír los trabajos de saneamiento sino a completarlos, a llenar su propio cometido y en varios casos a cambiar radicalmente nuestras ideas de control. Cuando de usaba exclusivamente petróleo o verde de París, las encuestas tenían que ser muy cuidadosas para que se pudieran apreciar los matices de control, con el uso efectivo de los nuevos insecticidas los cambios son tan notables que es posible hacer encuestas no muy finas pero si convenientes y que evitan esfuerzo y dinero. Estos nuevos compuestos han beneficiado a otros trabajos de saneamiento pues cuando el público valora las utilidades económicas o el mayor confort en el que vive y trabaja, está dispesto a ampliar los presupuestos ya existentes. La demanda de ampliación de servicios significa más personal debidamente entrenado y ampliación de los servicios de instrucción y adiestramiento de donde salen ingenieros sanitarios, entomólogos, farmacólogos, químicos, inspectores, operadores, etc.

El radio y la prensa se han adelantado a los programmas educativos oficiales y el público se mantiene informado acerca de los nuevos métodos de control más bien por la propaganda comercial. Si se ha de hacer una buena labor educativa ésta debe comprender un programa tanto para niños como para adultos, para poblaciones industriales y para pequeñas comunidades rurales, para grupos iletrados y para clases profesionales.

La introducción del DDT marca una etapa de transformación en diferentes actividades diarias gracias a su versatilidad pues puede ser usado en forma líquida o en polvo, usando diferentes solventes, emulsificantes, suspensores, aplicándolo con rociadores de mano o con equipo mecánico muy variado, barato o muy costoso. Por lo que se refiere a la construcción de casas o a su alambrado, se necesita una revisión de sus indicaciones. La lucha contra moscas y otros artrópodos está también en este caso y aunque la opinión unánime de los expertos es en el sentido de que el DDT no puede reemplazar al saneamiento, se requiere ver cómo el DDT puede completar esos trabajos.

Hoy que hay grandes programas de control de artrópodos domésticos transmisores de enfermedad sería muy de desear que se intensificaran los estudios relativos a prevalencia de tales artrópodos dentro de casas antes de que se iniciaran esos trabajos con el fin de obtener datos comparativos que sirvieran además para una mejor comprensión ecológica.

Los resultados obtenidos en trabajos de control se presentan mejor en reuniones que tienen un caracter general nacional, pero este tipo de reuniones a su vez, si cubren verdaderamente un campo amplio se transforman con mayor provecho en reuniones internacionales que pueden influenciar profundamente a su vez trabajos planeados para resolver problemas locales o regionales. Esta evolución en el desarrollo de las agrupaciones, y los programas de cooperación internacional, no sólo es deseable ni está proyectada por utopistas sino que es imperiosa toda vez qui ni las enfermedades ni la climatología o la biología en general obedecen a limita-

ciones políticas. Esta cooperación debe desarrollarse en la misma proporción en que se desarrollan las facilidades de transporte y de intercambio. La American Mosquito Control Association y las Asociaciones filiales deben considerar transformarse para la mejor realización de sus fines en organismos que estudien los métodos de control de artrópodos en general, con campo de acción internacional colaborando con instituciones tales como la Organización Mundial de la Salud a través de su organismo regional, la Oficina Sanitaria Panamericana o el Instituto de Cooperación Interamericana.

—DR. LUIS VARGAS,
Laboratorio de Entomologia
Instituto de Salubridad y
Enfermedades Tropicales
Mexico, D. F.

CONTRIBUTORS PLEASE NOTE

Heretofore there has been no definite policy regarding the disposition of authors' manuscripts, once the paper has appeared in MOSQUITO NEWS. The original manuscripts are returned with the galley proofs to the Editorial Office from the printer. The manuscripts, together with the originals of such photographs and charts as were included are then filed.

In the future this material will be destroyed after the paper has been published, unless other instructions are received from the author at the time his galley proofs are returned to the editorial office.

The manuscripts on hand, of papers published during the past few years, will also be destroyed unless authors communicate with the editorial office and ask for their return before September 1, 1949.

NOTICE

We have been informed that the Entomological Society of Washington has assembled about 20 sets of short papers dealing with mosquitoes, nearly all written by Frederick Knab or H. G. Dyar. Most of the papers were published in the Proceedings of the Entomological Society of Washington during the period 1904–1916; a few appeared elsewhere. The sets vary from 30 papers, including about 120 pages, with 5 plates, to 21 papers and about 90 pages and 4 plates. Sets will be sold for one dollar, prepaid, the more complete sets being sold first. Orders should be sent to the Corresponding Secretary, Entomological Society of Washington, % U. S. National Museum, Washington 25, D. C.

REVIEWS AND ABSTRACTS

The Place of DDT as an Anopheline Larvicide. By G. Macdonald. Inst. de Med. Trop. An. 4:391–411, 1947. Although much attention has been devoted to DDT as an adulticide, the potentialities of it as an anopheline larvicide have not been fully explored. The author believes it possible that in most European countries the breeding of *Anopheles maculipennis* Meig. could be terminated in one season, at small cost by the full utilization of DDT as a larvicide.

After a brief review of the application of DDT larvicides in various parts of the world, he gives a few examples of the use of oils, with a high spreading coefficient, in India, Iran, and Portugal. In one instance in Iran the use of a 5 per cent DDT-resin-oil solution (0.25 mixture of resin in crude gas or fuel oil) in a date palm irrigation system (70 x 82 metres) reduced the time of application from 1 day to less than 10 minutes. Previously the process called for 4 laborers, a supervisor, 108 litres of oil, spraying machines which had to be transported in a vehicle with a driver, plus a service station and a staff to keep the equipment in order. However, under the new system one man who could apply a small amount of DDT in a fraction of the former time, was sufficient. In Assam, the author sprayed a 5 per cent DDT solution, in a few seconds, over a water covered hyacinth swamp containing larvae of *Anopheles hyrcanus* (Pallas) and *A. barbirostris* V. d. Wulp with the result that the next day larval destruction was complete. Other swamp areas in Assam were treated similarly. Previously this extensive series of swamps had been considered untreatable as the cost of the oil method was prohibitive and the use of paris green was difficult and dangerous owing to the irregularities in the bottom of the swamp. Control measures would have necessitated a supervisor with a large crew of men with rafts to reach the center of the breeding places but through the use of the DDT-resin-oil solution, one man could treat whole areas in an hour.

By the application of 5 per cent DDT in spreading oils to a single spot and by taking advantage of the distribution provided by running water, Dr. Macdonald feels that anopheline breeding in swamps, rice fields, irrigation channels, and streams can be made so easy that it can be universally and cheaply carried out.—Helen Sollers, U. S. Bureau of Entomology and Plant Quarantine.

A Preliminary Evaluation of Some Insecticides Against Immature Stages of Blackflies (Diptera: Simuliidae). By B. Hocking, C. R. Twinn, and Wm. C. McDuffie. Scientific Agriculture 29(2):69–80. 1949. DDT, gamma-benzene hexachloride, a pyrethrum-piperonyl butoxide preparation, toxaphene, and chlordane, were evaluated as insecticides against immature stages of blackflies. Two airplane applications and 16 hand applications were made to streams in the vicinity of Churchill, Manitoba, Canada, in June and July 1947. The predominating species of blackfly in all experiments was *Simulium venustum* Say.

The application of DDT in oil solution by airplane at dosages of 0.26 pound and 0.48 pound of DDT to the acre, early in the season, controlled blackfly species in streams up to 1½ feet deep which flowed through the sprayed area, and prevented reinfestation throughout the remainder of the season.

Direct hand applications were made with DDT in fuel oil and as a wettable powder and an emulsion. All the DDT formulations gave good control at 0.1 p.p.m., applied for a period of 15 minutes. None of the other materials compared favorably with DDT.

Eggs of *S. venustum* appeared to be unaffected by DDT in fuel oil at a dosage of 0.1 p.p.m. applied over a period of 30 minutes. Pupae in treated streams showed no obvious ill effects from the insecticidal applications, except for gamma-benzene hexachloride at 0.1 p.p.m. applied for a period of 15 minutes. This material gave a 70 per cent reduction in emergence from treated pupae of *S. venustum*.—C. C. Deonier, Bureau of Entomology and Plant Quarantine, Orlando, Fla.

The Pupae of the Mosquitoes of New Guinea. George Henry Penn. Pacific Science III (1):3–85, 58 fig. 1949. This, the first comprehensive work on mosquito pupae of New Guinea, embraces 68 species, or slightly over a third of the species now known of that fauna. Thirty-six species are fully described and illustrated for the first time, and the dorsal setae of all abdominal segments are illustrated for 45 species. Keys to thirteen genera and 24 subgenera of Culicinae are presented, as well as keys to the included species. The species of *Megarhinus* are reserved for a future paper, and the author did not have material of *Hodgesia* or *Mansonia*. *Bironella* is not separated from *Anopheles*. The keys are preceded by a five page discussion of features of taxonomic importance. The author presents a table comparing the nomenclature of the dorsal abdominal setae of Macfie (1920), Senevet (1930), Baisas (1936 and 1938), and Rozeboom and Knight (1946), and his slight adaptation of the terminology of Baisas (1938). He wisely did not adopt the numerical system of Rozeboom and Knight, but the reviewer believes that the numerical system proposed by Knight and Chamberlain (1948, in Proc. Helminth. Soc., Washington), will be welcomed by most workers in the field.

Because of the general neglect of pupae by sys-

tematists, it is well to point out the author's statement: ". . . the pupae of most species of the genera *Aedes* and *Culex* are more readily grouped into their respective subgenera than into their respective genera. On the other hand, specific differences seem to have been accentuated, and pupae of (some) very closely related species . . . are more easily separated than are the adults."

The author is to be congratulated on this work. It is well organized and arranged. The keys and descriptions are in great part original, and complete enough for subsequent workers to use as a basis for comparison. A brief diagnosis is given of the salient features of most genera, subgenera and species, and this further enhances the usefulness of the work. The drawings of the abdomen are very carefully executed, but many workers would like to see figures included for the trumpet of each species. Fifty references are cited.—Harold R. Dodge, Communicable Disease Center, Public Health Service, Atlanta, Georgia.

CHRONICLE OF THE WORLD HEALTH ORGANIZATION. 3(1):1–22. Jan. 1949. WHO, Palais des Nations, Geneva, Switzerland. 1949 subscription $2.00. (U. S. Address: Columbia Univ. Press, International Documents Service, 2960 Broadway, New York 27, N. Y.) This is one of a series of attractive booklets published monthly, in English, French, Russian, Spanish, and Chinese. Information is set forth in an interesting manner, often in some detail. The reports of the Expert Committees, abstracts of important WHO publications, news notes, and general activities are included. The "Chronicle," however, calls attention to the fact that it does not claim to be an authoritative record of the Organization's views, such as may be found in the "Official Records." The first 15 pages consist of the following: "First Session of the Expert Committee on International Epidemiology and Quarantine," "Malaria in Europe, 1938–1947," "Influenza in Europe," "Eastern Mediterranean Conference," "Serology of Syphilis," and "Penicillin in Venereal Diseases."—H. L. T.

THE MOSQUITOES OF BWAMBA COUNTY, UGANDA. VI. MOSQUITO BREEDING IN PLANT AXILS. Haddow, A. J. Bull. Ent. Res. 39(2):185–212, 7 plates. Aug. 1948. This paper is one of a series reporting studies on mosquitoes in an area of endemic yellow fever in western Uganda, northwest of Lake Victoria, in west central Africa. The principal vector of yellow fever in the inhabited area is *Aedes simpsoni* Theo., which was found naturally infected. This mosquito breeds in the water held in the leaf-axils of many cultivated food-plants, and the adults are "semi-domestic," daybiting, and prefer human blood.

The plants studied include wild and cultivated bananas (including plantains), colocasias ("elephant-ears," *Xanthosoma* spp.); pineapples; *Sansevieria* or "bowstring-hemp"; *Pandanus,* or "screw-pine"; *Dracaena* spp.; and *Canna* sp. The most important of these from the standpoint of mosquito breeding were the colocasias, the pineapples and the "gonja" group of large cultivated bananas. Leaf-axils containing 4 to 8 cc. of water were the most favorable for *A. simpsoni.* Twelve consecutive monthly surveys of colocasia plants showed that *simpsoni* larvae were constantly present in their leaf-axils; fluctuations in numbers of larvae depended on the state of maturity and the harvesting of plants, rather than on rainfall. Collections of pupae from colocasias gave an estimate of 10 adults per plant per month, under favorable conditions. Predatory mosquito larvae seemingly reduce considerably the numbers of *simpsoni* larvae. The paper is an excellent account of much meticulous, well-planned work on the ecology of a semi-domestic mosquito.—W. H. W. Komp N. I. H. Bethesda, Maryland.

COMBATE ESPECIFICO AO VETOR DE MALÁRIA, EM ZONA DE TRANSMISSAO POR ANOFELINOS DO SUB-GÊNERO "KERTESZIA." Ferreira, Mária O. Resumos de Malariologia e Doenças Tropicais 1(1):17. 1948. (Brazil.) The principal anopheline vectors of malaria along the coasts of three Brazilian states, Paraná, Santa Catarina and Rio Grande do Sul, are species of the subgenus *Kerteszia,* which breed in water in arboreal bromeliads. Small towns in forested areas suffer severely from malaria. Application of herbicides to kill the bromeliads is impracticable, owing to the great height of the trees on which they grow. Removal of the bromeliads by hand was tried, but proved costly and dangerous. Removal of the forest about a town, followed by planting of cultivated crops in an inner zone, and reforestation of the outer zone with trees, especially *Eucalyptus,* which do not harbor bromeliads, is believed to be the method of choice in control of urban malaria transmitted by the *Kerteszia* species.—W. H. W. Komp.

MOSQUITO CONTROL AT ROSEMERE. Mimeographed circular of Anti-Mosquito Committee, Rosemere Citizens Assoc. Inc., R. C. Gardiner, Chairman. 5 pp. 1948. Rosemere, Quebec, Canada. An interesting report has come from Canada. It tells the story of the struggle by a small community to fight the hordes of flood-water mosquitoes, with a less-than-minimum budget and volunteer labor.

Mosquito control has been in progress at Rosemere, near Montreal, since 1943. In that year, an Anti-Mosquito Committee organized crews of voluntary workers. They poured waste crank case oil on swamp areas and spread it with brooms; a method that has some effect in the deeply flooded swamplands in the North. The committee studied its mosquito problem carefully and was alert to the current developments in mosquito control elsewhere in Canada and in the United States. In 1945, a large size stirrup pump was acquired and fuel oil was used. In

1946, six small hand dusters were purchased and some 3 per cent DDT dust was applied at the rate of 1 lb. per acre. This gave excellent results on the spring brood of mosquitoes, but there was some hatching of other species when severe floods occurred later in the season. In 1947, the committee purchased five 4 gallon sprayers. It also had the use of a Buffalo Turbine duster. In addition to DDT dust a quantity of 25 per cent emulsifiable DDT was used. Good results were obtained using the equivalent of 3 gallons per acre of 1 per cent DDT spray in a single application. The Buffalo Turbine blower proved somewhat of an asset in dusting areas where flood waters were too deep for wading. In 1948, six more 4 gallon sprayers were purchased with $50 granted by the Municipality of Rosemere. The committee divided Rosemere into 9 districts and appointed an organizer for each. These organizers were charged with the duties of arranging volunteer working parties of 6 to 12 volunteers, for checking breeding areas twice weekly and determining where spraying should be done. The program called for one application of 1 lb. of DDT per acre, with a further treatment if necessary. Plans were also made for fall treatment with DDT.—Robert L. Armstrong, East Middlesex Mosquito Control Project, Cambridge, Mass.

(A recent personal communication from Mr. Gardiner gives additional information. Unfortunately there was insufficient labor, and the 1948 results were about 50 per cent effective. This shortage of volunteer labor also made it impossible to carry out the fall program. This year (1949) the committee plans to use oil on the large open areas and DDT on the remainder. It plans to finish all work by May 1. An attempt is being made to establish a permanent organization with an advisory committee. They hope to obtain worthwhile financial support from Municipal authorities.—R. L. A.)

PROCEEDINGS OF THE 4TH INTERNATIONAL CONGRESSES ON TROPICAL DISEASES AND MALARIA. Dept. of State Publication 3246. 1948. Two attractive volumes carrying the proceedings of the 4th International Congresses on Tropical Medicine and Malaria came from the Government (U. S.) Printing Office in March (1949). The 1810 pages of these volumes are full of up-to-date information on all aspects of tropical medicine presented by the world's leading authorities.

As would be expected, a considerable part of these volumes deals with malaria and mosquito problems (pp. 601–946 in Vol. 1, and 1563–1608 in Vol. 2) with numerous references in many sections.

In addition to the material in these sections of the proceedings one article deals with new insecticides, one with the toxicology of the newer insecticides, one with the chemistry and formulation of insecticides and one with equipment for dispersing insecticides.

The addresses by Maj. Gen. Raymond Bliss, Dr. Fred L. Soper and Dr. Philip S. Hench at the exercises commemorating the demonstration by Walter Reed of mosquito transmission of yellow fever are of special interest and historic value.

The addresses presented at the evening meeting in commemoration of the 50th anniversary of the discovery by Ronald Ross of the method of transmission of malaria are also of much interest and value. They were presented by Professor George MacDonald, Dr. Paul F. Russell and Sir Malcolm Watson.

The contributions contained in these proceedings, reviewing as they do the accomplishment in preventive medicine during a period of unprecedented progress in that field, are of great value to medical men, sanitary engineers, entomologists and in fact to all those concerned with public health matters.

The articles are mainly in English with a few in Spanish and French. Discussion on the various papers is included. The books are illustrated with numerous charts and photographs with several plates in color, the typography is excellent and the bibliographies cover most of the important literature in the many fields treated.

The general secretary, Dr. Wilber A. Sawyer and the editors, Carolyn Whitlock and Gertrude Henderson are to be congratulated on a difficult job well and promptly done.

The volume can be purchased from the Supt. of Documents, Government Printing Office. Washington, D. C.; Volume 1 is $5.00 and Volume 2 $6.00.—F. C. Bishopp.

SPECIES ERADICATION. THE ERADICATION OF ANOPHELES GAMBIAE FROM UPPER EGYPT 1942–1945. By Sir Aly Tewfik Shousha, Pasha, M.D., Under-Secretary of State, Ministry of Public Health, Cairo, Egypt. Bulletin of the World Health Organization, Vol. 1, No. 2, 1948, pp. 309–352. A severe epidemic of malaria, 71.5 per cent of the population of four villages, in the Lower Egyptian Nubia district in March 1942 heralded the presence of *Anopheles gambiae* in Egypt. The vector's presence was recorded at Aswan in July 1942. The northern limit was determined to be just north of the city of Asyut in September. The area invaded was a narrow strip of land 4,270 square kilometers, having a population of 3,000,000 people. The number of deaths from malaria in this area from 1942 through 1945 was estimated to be 11,889. The total number of deaths in 1945 and 1946 was 31.

The Gambiae-Eradication Service was created in July 1944 and from this date until 19 February 1945, the date the last *gambiae* was found in Egypt, an intensive and well organized campaign was waged. Extensive control measures were continued for a period of six months following the collection of the last *gambiae,* terminating at the end of August. The next three months, those most favorable to *gambiae,* were

used as a test period. During the test period 1,200 daily-paid workers, whose job depended on finding the vector, were engaged in extensive survey. Yet, no *gambiae* was found.

It was an excellent organization which carried out the eradication work. The Rockefeller Foundation representatives, Dr. T. L. Soper, Dr. J. A. Kerr, and Dr. D. Bruce Wilson helped organize the work along the lines used in the eradication of *A. gambiae* in Brazil. Dr. Kerr became Director of the Gambiae-Eradication Service and Dr. Wilson, Field Director in 1944.

The unit of the organization was the zone (darak) which was an area that one man, and a laborer, could cover in a week. The man in charge (mulahez) was responsible for larviciding only. Five zones comprised a district (magmoua) with a foreman (morakeb) in charge. His duties were to train and supervise the men in the zones and to make routine and systematic larval checks. Both the mulahez and the morakeb were required to record in detail all the work they performed and the materials they used.

A variable number of districts made up one post (dairah) which had a doctor or engineer in charge. Aside from the districts and zones under the dairah chief, there were mobile survey units for collecting and checking larvae and adults. These were called imago kashshafin and larva kashshafin. At the height of the campaign there were 612 kashshafins checking the work of 1,000 Paris-green mulahezin.

The post was responsible to the Division (moutikah) which had an experienced malaria doctor in charge. Field headquarters and laboratory was located at Asyut. At the peak of the campaign there were 10 divisions, 44 posts and 641 zones engaged in the eradication work.

A therapeutic service was established at Luxor in 1944 to treat the thousands of malaria patients. The area was divided into 16 therapeutic divisions with a chief malaria inspector and 80 doctors. There were 62 treatment posts with 117 chief inspectors, and 856 inspectors in the treatment zones.

Everything needed to control malaria in 1942 was scarce. The service chose Paris green dust (1 to 100) for the larvicide. Oil was used only until it could be replaced by Paris green. Pyrethrum was used for adult spraying and to facilitate adult checking. DDT was used as a residual spray in trains, boats and aeroplanes to prevent the spread of *gambiae*.

The figures on amounts of insecticide are given since it is a useful index of the amount of work performed. During the campaign 138 tons of Paris green were used, 718 tons of malariol, 146,173 liters of pyrethrum and 4,773 liters of (5%–10%) DDT were used.—A. B. Weathersby, Naval Medical Research Institute, Bethesda, Md.

A PRELIMINARY ACCOUNT OF THE BITING FLIES AT CHURCHILL, MANITOBA. By C. R. Twinn, B. Hocking, Wm. C. McDuffie, and H. F. Cross. Can. J. of Res. 26(6):334–357. Dec., 1948. Published by Natl. Res. Coun., Ottawa, Canada. The observations on which this paper were based were made during the spring and summer of 1947 as a joint project of the Canadian Division of Entomology and the U. S. Bureau of Entomology and Plant Quarantine. The authors in a footnote name and acknowledge the valuable assistance rendered by other members of the party. The following abstract presented at the beginning of this article is a concise statement of the scope and content.

> "The occurrence is recorded at Churchill, Manitoba, of 5 genera and 11 species of Culicidae, 2 genera and 12 species of Simuliidae (3 and possibly 4 of which may be new to science), and 2 genera and 10 species of Tabanidae. Data are presented on their habitats, life histories, habits, species association and succession, and relative abundance and distribution. Observations on the relationships of these insects to other organisms are recorded, including notes on their status as pests and their influence on human activities in the locality. Evidence is presented that female mosquitoes feed on the nectar of flowers and are efficient pollinators of northern orchids. A brief general picture of the ecology of the locality is given; also details of weather conditions during the period of the survey, and some microclimate data. Illustrations from photographs showing typical habitats of many of the species dealt with are included."

The article is well organized, carefully prepared and interestingly presented. The description of the area, accompanied by 12 photographs, clearly illustrate the different types of situations investigated. Perhaps the most valuable contribution is the specific data presented for each species. This consists, for most of the major species, of exact dates on development, emergence, abundance, feeding habits, seasonal duration, and is accompanied by some specific meteorological data. In addition, information on the area or species involved obtained from other sources, is frequently cited throughout the article. The most unfortunate circumstances pertaining to the investigation is the recognized inability to identify with accuracy "flown" adult female specimens of certain dark-legged species of mosquitoes. This invalidated the use of much data in its application to specific species. The article is highly commendable and in recognition of the importance of "species sanitation," contains valuable information concerning the biting flies of subarctic North America.—Don M. Rees, U. of Utah, Salt Lake City, Utah.

REPORTS FROM MOSQUITO CONTROL DISTRICTS — H. L. T.

SUMMARY OF THE ANNUAL REPORT OF THE SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT FOR 1948. Prepared by Don M. Rees. 401 City

and County Bldg., Salt Lake City, Utah. During the past year, an area of 182 sq. miles was supervised by the District. The tax levy was .3 of one mill for 1948 and will be the same for 1949. The Report states that during 1948, control work "was effective but the results were not as satisfactory as they were in 1947." Public complaints were more numerous than in the past, and this is attributed to the increase in numbers of mosquitoes and the change in dominant species. Prior to 1948, *Culex tarsalis,* a timid, night biter, was the dominant species. According to light trap data, this species decreased by 48 per cent, whereas an aggressive, vicious biter, *Aedes dorsalis,* increased by 28 per cent. *Aedes vexans,* with similar habits, increased 6 per cent. It was late in the season when some black gnat control was begun; a residual spray and "knock-down" adulticide were used.

SACRAMENTO COUNTY-YOLO COUNTY MOSQUITO ABATEMENT DISTRICT. First annual report. July 1, 1947–June 30, 1948. 24 pp. 5 plates. George Umberger, Sup. Rm. 216-D, Court House, Sacramento, Calif. This district covers 2,013 sq. miles, including valley, foot-hill, and delta sections. Malaria is endemic, and encephalitis an ever-present threat. Fourteen species of mosquitoes are listed, the most prevalent, *Anopheles freeborni* and *Culex tarsalis* being vectors of malaria and encephalitis respectively. The tax rate for the year was set at 2¢ per $100.00 assessed valuation.

DADE COUNTY ANTI-MOSQUITO DISTRICT 14TH ANNUAL REPORT. 1948. 13 pp. Fred H. Stutz, Director; James H. Heidt, Entomologist. Rm. 1909 Dade Co. Court House, Miami, Fla. No *Anopheles albimanus* were collected in the County in 1948. Mosquito light traps yielded 19 species of mosquitoes. *Psorophora confinnis* was more annoying during the year than salt marsh species. Airplane spraying by a commercial firm covered approximately 15,580 acres. The cost per acre averaged .254¢ (excluding truck servicing, mixing, and supervision). A laboratory has been set up, and preliminary field work on the difficult project of sand fly abatement was started during the year.

EIGHTH ANNUAL REPORT OF THE VIRGINIA BEACH-PRINCESS ANNE COUNTY MOSQUITO CONTROL COMMISSION. July 1, 1947–June 30, 1948. 6 pp. R. E. Dorer, Vice-Chairman; Richard Carter, Superintendent. The Commission personnel used one jeep equipped with a pressure sprayer and a fogger. With a new larvicide and this jeep, a greater efficiency has been obtained. As many as 58 miles of roadside ditch have been sprayed in one day. All inspectors carry "pocket-size" pressure sprayers, holding enough larvicide to treat about 150 feet of ditch or numerous small breeding areas. The most perplexing problem is control of *Mansonia perturbans* breeding in a State Park.

ANNUAL REPORT WARWICK COUNTY MOSQUITO CONTROL COMMISSION. July 1, 1947–June 30, 1948. 3 pp. S. Gibson and J. C. Morris, Commissioners; N. S. Beaton, Sec.-Supt., Hilton Village, Va. The cost of mosquito abatement in the county (est. pop. 35,000) was about 32.9¢ per capita. A new mixture, fuel oil, DDT, and a spreader called Triton B-1956, was used as a larvicide, with a noticeable decrease in expenditure because of the efficiency of the spreader. Of 2,789 backyards inspected, only 7 per cent revealed mosquito breeding places; this good record is attributed to the fine cooperation of the property owners who aided in the elimination of such sources of infestation. To date, there are approximately 30 miles of concrete-lined ditches in the county.

ANNUAL REPORT ELIZABETH CITY COUNTY MOSQUITO CONTROL COMMISSION. July 1, 1947–June 30, 1948. 3 pp. S. M. Gibson and W. R. Freeman, Jr., Commissioners. N. S. Beaton, Supt. Mosquito abatement in this county (est. pop. 54,000) was carried on at a cost of 23.7¢ per capita. A solution of DDT, D-30, and Triton B-1956 was added to the fuel oil used for larviciding; the spreading power of the larvicide was greatly increased. For example. 710 gallons covered 1,062,900 lineal feet of ditch. Concrete ditch liners were installed during the year; projects call for a continuation of this installation in the future, several thousand more lineal feet being planned.

ANNUAL REPORT OF THE TOLEDO AREA SANITARY DISTRICT, YEAR 1948. 27 pp. H. A. Crandell, Supt., P. Bruce Brockway, Jr., Field Supervisor. 5015 Stickney Ave., Toledo 12, Ohio. This second annual report devotes the first 5 pages to a history, description, and mosquito control problems of the District. Chapters on entomological data, control operations, etc., follow. During 1948, 25 species of mosquitoes were collected. A large-scale experimental pretreatment program for the control of early spring or woodland breeders was undertaken; the results exceeded expectations. In the course of this project, wettable and dry DDT dusts were compared; and "repeated checks and larval counts indicated there was no observable or significant difference" between them in larvicidal effectiveness. For most effective adult control, the District added 4 per cent DDT by weight to a Gulfspray "Insect Killer" (wartime formula) containing 3.55 organic thiocyanates. Plans for 1949 include construction of a 50 ft. propagating pond for *Gambusia.*

BIBLIOGRAPHY

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO CONTROL WORKERS AND MALARIOLOGISTS

H. H. STAGE AND HELEN SOLLERS

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

ANONYMOUS. 1948. False positive tests in malaria. U. S. First Army Med. Bul. 3(10):19–21.

———— 1948. Mosquito is hero of new malaria test. Sci. Illus. 3(12):59–61.

———— 1948. Asociacion interamericana de ingenieria sanitaria. Pan Amer. Union, Bol. de la Ofic. Sanit. 27(7):631–640.

———— 1948. WHO malaria committee reports on second session. Natl. Malaria Soc. Jour. 7(4):307–310.

———— 1949. Eradication of malaria in Holland. Amer. Med. Assoc. Jour. 139(8):541–542.

———— 1949. Malaria control measures. Jour. Trop. Med. and Hyg. 52(1):18–19.

ABDEL-MALEK, A. 1948. The biology of *Aedes trivittatus*. Jour. Econ. Ent. 41(6):951–954, 2 refs.

AFRIDI, M. K., AND SINGH, D. 1947. A scheme for the control of malaria in villages in Delhi Province. Indian Jour. Malariol. 1(4): 423–440, 4 refs.

AFRIDI, M. K., RAMAKRISHNAN, S. P., GOSWAMI, A., AND MENON, M. K. 1947. An enquiry on certain aspects of paludrine. Indian Jour. Malariol. 1(1):221–229, 3 refs.

AITKEN, T. H. G. 1948. Recovery of anopheline eggs from natural habitats, an aid to rapid survey work. Ent. Soc. Amer. Ann. 40(3): 327–329, 3 refs.

ALVARADO, C. A. AND COLL, H. A. 1948. Programa para la erradicacion del paludismo en la Republica Argentina. Pan Amer. Union. Bol. de la Ofic. Sanit. 27(7):585–602.

ARANGO, J. J. 1948. The history of the mosquito-malaria theory. I. Medical Bookman and Historian 2(8/9):345–348, 4 refs.

ARNETT, R. H., JR. 1948. Notes on the distribution, habits, and habitats of some Panama Culicines (cont'd.) N. Y. Ent. Soc. Jour. 56(3): 175–193.

ASHWORTH, R. DE B. AND COWORKERS. 1948. Synthetic antimalarials. XXIV. Some 2-Phenylureido-and 2-Phenylthioureido-4-dialkylaminoalky-lamino-6-methylpyrimidines. [London] Chem. Soc. Jour. May:581–586.

AZEVEDO, J. F. DE, CAMBOURNAC, F. J. C., AND PINTO, M. R. 1947. Results of a study on yellow fever in Portuguese Guiana. Inst. de Med. Trop. An. 4:17–24.

———— 1947. Observations on the incidence of malaria in Portuguese Guiana. (Prelim. Note). Inst. de Med. Trop. An. 4:7–15.

BALDI, A. AND DEL GIUDICE, V. 1948. Sui vantaggi delle dosi iniziali alte nella terapia con acridinici; studio comparativo. Riv. di Malariol. 27(2):111–122.

BALZAR, M. 1948. Il pericolo della malarioterapia praticata in zone con anofelismo. Riv. di Malariol. 27(2):65–70.

BASU, B. C. 1947. Abnormal development of malarial oocysts in *Anopheles stephensi*. Indian Jour. Malariol. 1(1):129–132, 2 refs.

———— 1947. The frequency of distribution of gametocytes of the Indian strains of malaria parasites. Indian Jour. Malariol. 1(1):123–127, 3 refs.

BATES, M. AND DE ZULUETA, J. 1949. The seasonal cycle of anopheline mosquitoes in a pond in Eastern Colombia. Amer. Jour. Trop. Med. 29(1):129–150, 27 refs.

BELTRAN, E. AND VILLASANA, L. 1948. El paludismo en el districto federal. Caracteristicas de una cepa de *Plasmodium vivax* aislada en xochimilco. Rev. Inst. Salubridad y Enferm. Trop. [Mexico] 9(1):21–25, 8 refs.

BERBERIAN, D. A. AND DENNIS, E. W. 1948. Field experiments with chloroquine diphosphate. Amer. Jour. Trop. Med. 28(6):755–776, 19 refs.

BETTINI, S. AND TENTORI, L. 1948. Insects and vitamins. I. Synthetic review. II. Vitamins A and E in *Anopheles labranchiae atroparvus*. Inst. Super. di Sanit. Rend. 11(1):109–122.

BETTINI, S. 1948. Cases of malaria treated with paludrine. Riv. di Parassitol. 9(2):107–111.

BICK, G. H. 1948. Resistance of *Culex quinquefasciatus* Say larvae and pupae to experimental drought. Ent. Soc. Amer. Ann. 40(3):360–368, many refs.

BIJLMER, J. AND KRAAN, H. 1948. Is the gametocyte production of *Plasmodium vivax* influenced by elimination of the mosquito passage? Jour. Trop. Med. and Hyg. 51(11):222–225, 3 refs.

BISHOP, A. AND MCCONNACHIE, E. W. 1948. Resistance to sulphadiazine and paludrine in the malaria parasite of the fowl, *P. gallinaceum*. Nature [London] 162 (4118):541–543.

BLACKBURN, C. R. B. 1948. Observations on the development of resistance to *vivax* malaria. Roy. Soc. Trop. Med. and Hyg. Trans. 42(2): 117–162, 23 refs.

BLACKIE, W. K. 1947. Malaria with special reference to the African forms. 104 pp., Capetown.

BOHART, R. M. 1948. A comparison of DDT and dichlorodiphenyl dichlorethane as larvicides

for *Aedes* mosquitoes. Jour. Econ. Ent. 41(5): 834–835, 5 refs.

———— 1948. Differentiation of larvae and pupae of *Aedes dorsalis* and *Aedes squamiger*. Ent. Soc. Wash. Proc. 50(8):216–218, 4 refs.

———— 1948. The subgenus *Neoculex* in America north of Mexico. Ent. Soc. Amer. Ann. 40(3):330–345, 14 refs.

BONNE-WEPSTER, J. 1948. Results of the third Archibald Expedition 1938–39. (Diptera, Culicidae). Notes on the mosquitoes collected by the Neth. Indian-Amer. Expedition to Central and North New Guiana. Treubia 19(2):305–322, 19 refs.

BORKENSTEIN, E. 1948. Uber die malaria-provokation. Praktischer Arzt 2(13):229–235, 7 refs.

BOVET, D., AND COWORKERS. 1948. Activity of nivaquine, nivaquine B, paludrine and metachloride in avian malaria. Soc. de Path. Exot. Bul. 41(3–4):268–274, 16 refs.

BRELAND, O. P. 1948. Notes on some carnivorous mosquito larvae. Ent. News 59(6):156–157.

———— 1948. Some bicolored mosquito larvae. Kans. Ent. Soc. Jour. 21(4):120–121, 5 refs.

BROMLEY, S. W. 1948. Insect predators of mosquitoes. Ent. Soc. Wash. Proc. 50(9):235–238.

BURGESS, R. W. 1948. The experimental hybridization of *Anopheles quadrimaculatus* Say and *Anopheles maculipennis freeborni* Aitken. Amer. Jour. Hyg. 48(2):171–172, 3 refs.

BUSTOS-CASTELLANOS, J. AND COWORKERS. 1949. A malaria reconnaissance of the State of Veracruz, Mexico. Amer. Jour. Trop. Med. 29(1): 23–35.

CALLOT, J. 1947. Etude sur quelques souches de *Culex pipiens* (sensu lato) et sur leurs hybrides. Ann. de Parasitol. Humanine et Compar. 22(5–6):380–393, 5 refs.

———— 1947. Sur les larves de *Culex hortensis* Fic. et de *C. deserticola* K. Ann. de Parasitol. Humaine et Compar. 22(5–6):480–481, 2 refs.

CASTANA, V. AND MILANI-COMPARETTI, P. 1947. Studi sulla splenoriduzioni nella malaria con sympatol e adrenalina. Riv. di Malariol. 26(3): 137–152, 16 refs.

CAUBET, P. AND COWORKERS, 1948. Les moustiques du genre *Anopheles* a la Martinique. Inst. Pasteur de la Martinique 1(1):9–11.

CENTRAL CO-OPERATIVE ANTI-MALARIA SOCIETY LTD. 1948. Annual report for the twenty-eighth year (1947). 48 pp., Calcutta.

CHACKO, J. D. 1948. Filariasis. Christian Med. Assoc. India, Jour. 23(5):220–223.

CHAUDHURI, R. N., RAI CHAUDHURI, M. N., AND CHAKRAVARTY, N. Y. 1948. Chloroquine (SN 7618) in malaria. Indian Jour. Malariol. 2(1–2):1–12.

CHOU, T. Q., FU., F. Y., AND KAO, Y. S. 1948. Antimalarial constituents of Chinese drug, Ch'ang Shan, *Dichroa febrifuga* Lour. Amer. Chem. Soc. Jour. 70(5):1765–1767.

CHWATT, L. J. 1948. A new *Aedes* from the Cameroons, *A.* (*Aedimorphus*) *boneti* s. sp. *kumbae* s. sp. nov. Ann. Trop. Med. and Parasitol. 42(2):184–189, 5 refs.

CIUCA, M., BALIFF, L., AND CHELARESCO, M. 1948. Trials of causal prophylaxis of malaria with paludrine. World Health Organ. Bul. 1 (2):297–300.

CIUCA, M. AND COWORKERS. 1948. Preliminary note on the therapy of malaria with paludrine in experimental infection by inoculation of infected blood. World Health Organ. Bul. 1 (2):301–307.

CLIFFE, W. H. AND COWORKERS. 1948. Synthetic antimalarials. XXIII. 2-Arylguanidino-4-aminoalkylamin-opyrimidines. Further variations. [London] Chem. Soc. Jour. May:574–581.

COGGESHALL, L. T. AND RICE, F. A. 1949. Cure of chronic vivax malaria with pentaquine. Amer. Med. Assoc. Jour. 139(7):437–438, 3 refs.

CORKILL, N. L. 1948. Activation of latent kala-azar by malaria and relapsing fever. Ann. Trop. Med. and Parasitol. 42(2):230–235, 7 refs.

———— 1948. Activation of latent kala-azar and malaria by battle experience. Ann. Trop. Med. and Parasitol. 42(2):224–229, 6 refs.

CORRADETTI, A. 1947. Aspectos del problema malarico nundial y medios para su solucion en la costa del Peru. Publ. Dir. Gen. de Salud. Publica. Dept. de Malaria, Apr. 11, 15 pp.

———— 1947. Caracteres del problema malarico en la Costa, Sierra y Selva del Peru, y lineas generales de un plan de lucha nacional contra la malarica. Publ. Dir. Gen. de Salud. Publica. Dept. de Malaria. Dec. 9, 8 pp.

———— 1947. Experimental basis of malaria control on the coast of Peru. Publ. Dir. Gen. de Salud. Publica. Dept. de Malaria. Aug. 7, 14 pp.

COVELL, G. 1947. The malaria institute of India, 1938–47. Indian Jour. Malariol. 1(1): 1–36, 2 refs, and classified list of publications containing over 300 refs.

CRAIGE, B. JR. AND COWORKERS. 1948. A lichen-planus-like eruption occurring during the course of chloroquine administration. Jour. Clin. Invest. Suppl. 27(3):56–59, 10 refs.

CROWTHER, A. F. AND COWORKERS. 1948. Synthetic antimalarials. XXV. Some 4-Arylguanidino-2-and 6-dialkylaminoalkylamino-pyrimidines. [London] Chem. Soc. Jour. May:586–593.

CULWELL, W. B. AND COWORKERS. 1948. Studies in human malaria. XX. The intramuscular administration of chloroquine. Natl. Malaria Soc. Jour. 7(4):311–315, 10 refs.

CURTIS, A. C. AND HORNE, S. F. 1948. Neurosyphilis; a comparison of treatment plans using penicillin and a combination of penicillin and malaria. Mich. Med. Soc. Jour. 47(10):1111–1115.

CUTHBERTSON, W. W. AND MOFFATT, J. S. 1948. Contributions to the chemistry of synthetic antimalarials. VI. Some derivatives of 1: 3:5-Triazine. [London] Chem. Soc. Jour. May: 561–564.

D'AMBRA, G. B. 1948. Tecnica della pro-

filassi antianofelica in Italia. Riv. di Malariol. 27(2):71–82.

DAVIS, B. D. 1948. Complement fixation with soluble antigens of *Plasmodium knowlesi* and *Plasmodium lophurae*. Jour. Immunol. 58(3): 269–281, 1 fig.

DEANE, L. M., CAUSEY, O. R., AND DEANE, M. P. 1948. Notas sobre a distribuicao e a biologia dos anofelinos das regioes Nordestina e Amazonica do Brasil. Rev. Serv. Esp. de Saude Pub. 1(4):827–965, 34 refs.

DE BURCA, B. AND FORSHAW, H. W. 1947. Winter variations of the larva of *A. fluviatilis* from northern India and Bombay presidency. Indian Jour. Malariol. 1(4):417–418, 1 ref.

DE BURCA, B. AND JACOB, V. P. 1947. Further notes on malaria in Fort Sandeman. Indian Jour. Malariol. 1(4):413–416, 3 refs.

DE NEGRI, U. 1946. Sorgenti metanifere e malaria nel Polesine. Riv. di Malariol. 25(6): 217–223.

DE ZULUETA, J. AND BATES, M. 1948. Laboratory experiment with selection of oviposition site by *Anopheles darlingi*. Amer. Jour. Hyg. 48(3):350–360.

DICK, G. W. A. AND SMITHBURN, K. C. 1949. Immunity to yellow fever six years after vaccination. Amer. Jour. Trop. Med. 29(1):57–61, 6 refs.

D'IGNAZIO, C. 1947. Clinical differential diagnosis of malaria and relapsing fever. Soc. Ital. di Med. e Igiene Trop. 7(5–6):416–422.

DONGEN, K. VAN. Enige nieuwe geneesmiddelen tegen malaria. Nederland. Tijdschr. v. Geneesk. 92(35):2624–2628.

DOW, R. P. AND DAHL, A. H. 1948. Relationship between water impoundment and mosquito breeding in California. Fed. Security Agency, U. S. Pub. Health Serv., C. D. C. Bul. Oct.-Dec.:26–32.

DOWNS, W. G. AND BAKER, R. H. 1949. Experiments in crossing *Aedes* (*Stegomyia*) *aegypti* Linnaeus and *Aedes* (*Stegomyia*) *albopictus* Skuse. Science 109(2826):200–201, 5 refs.

DUBIN, I. N. 1948. Hypersensitivity in Simian malaria. Natl. Malaria Soc. Jour. 7(4): 265–274, 12 refs.

———— 1948. A search for exoerythrocytic forms in human malaria by means of tissue cultures of bone marrow. Natl. Malaria Soc. Jour. 7(4):330–332, 6 refs.

DULANEY, A. D. AND COWORKERS. 1948. The complement content of human sera with especial reference to malaria. Jour. Clin. Invest. 27(3): 320–326, 18 refs.

EDGAR, S. A. AND WILLIAMS, O. M. 1948. Effect of mosquitoes on poultry. Poultry Sci. 27(5):660.

EXPERT COMMITTEE ON MALARIA, INTERIM COMMISSION, WORLD HEALTH ORGANIZATION. 1948. Malaria control. Survey and recommendations. World Health Organ. Bul. 1(2):213–252.

EXPERT COMMITTEE ON MALARIA, WHO. 1947–1948. Extract from the report on the first session. World Health Organ. Bul. 1(1):21–28.

FAUST, E. C. 1948. Malaria in the United States today. Modern Med. 16(11):35–38, 106, 108, 110, 112, 114.

————, AND HEMPHILL, F. M. 1948. Malaria mortality and morbidity in the United States for the year 1946. Natl. Malaria Soc. Jour. 7(4):285–292, 2 refs.

FIELD, J. W. 1947. Paludrine: a general review. Malaria Advisory Board, Malayan Union, Med. No. 3, 42 pp., 21 figs. Kuala Lumpur.

FLOCH, H. 1947. L'endemo-epidemie palustre en Guyane Francaise. Inst. Pasteur de la Guyane et du Territoire de L'Inini. No. 163 (Oct.):12 pp.

FOY, H. AND COWORKERS. 1948. Malaria and blackwater fever in Macedonia and Thrace in relation to DDT. Ann. Trop. Med. and Parasitol. 42(2):153–173.

GAHAN, J. B., GILBERT, I. H., PEFFLY, R. L. AND WILSON, H. G. 1948. Comparative toxicity of four chlorinated compounds to mosquitoes, houseflies, and cockroaches. Jour. Econ. Ent. 41 (5):795–801, 5 refs.

GALLIARD, H., HUARD, P., AND NGU, D. V. 1947. Recherches sur la filariose a *Wuchereria bancrofti*. Effets de l'intervention chirugicale et de l'extirpation des filaries sur le rhthme de la periodicite et sur la persistance des microfilaires. Ann. de Parasitol. Humaine et Compar. 22(5–6): 332–344, 8 refs.

GARNHAM, P. C. C. 1948. The incidence of malaria at high altitudes. Natl. Malaria Soc. Jour. 7(4):275–284, 13 refs.

———— 1948. Exo-erythrocytic schizogony in malaria. Trop. Dis. Bul. 45(10):831–844, many refs.

GAUD, J. 1947. Larves d'*Anopheles* a soies clypeales doublees. Ann. de Parasitol. Humaine et Compar. 22(5–6):394–396, 1 ref.

GHOSH, J. C. 1948. Treatise on malaria. Antiseptic [Madras] 45(9):597–620.

GIGLIOLI, G. 1948. Malaria, filariasis and yellow fever in British Guiana. Control by residual DDT methods with special reference to progress made in eradicating *A. darlingi* and *Aedes aegypti* from the settled coastlands. Brit. Guiana Med. Dept. Mosquito Control Serv. 226 pp., 64 refs.

GINSBURG, J. M. 1948. Toxicity of parathion to mosquitoes. Jour. Econ. Ent. 41(4):649–650.

GOKHALE, V. G., PHALNIKAR, N. L., AND BHIDE, B. V. 1948. Synthetic mosquito larvicides. Part I. Univ. Bombay Jour. 16(5):32–36.

GRASSI, B., BIGNAMI, A., AND BASTIANELLI, G. 1948. Ulteriori ricerche sul ciclo dei parassiti malarici umani nel corpo del zanzarone. Riv. di Parasitol. 9(4):1–8.

GUPTA, P. R., AND GUHA, P. C. 1948. Studies in antimalarials: some N'-(8-chloro-5-quinoly l) -N^5-substituted beguanides. Current Sci. [Bangalore] 17(6):185.

HADDOW, A. J. 1948. The mosquitoes of Bwamba County, Uganda. VI. Mosquito breeding in plant axils. Bul. Ent. Res. 39(2):185–214, 16 refs.

HADDOW, A. J., AND COWORKERS. 1948. Im-

plication of the mosquito *Aedes* (*Stegomyia*) *africanus* Theobold in the forest cycle of yellow fever in Uganda. Ann. Trop. Med. and Parasitol. 42(2):218–223, 12 refs.

HALLER, E. V. 1948. Die erkankungsdauer der malaria insbesondere der malaria tertiana. Ztschr. f. Hyg. u. Infektionskrank 128 (3–4): 379–387.

HARRIS, A., AND REIDEL, L. M. 1948. Evaluation of the complement fixation test for malaria. Amer. Jour. Trop. Med. 28(6):787–795, 8 refs.

HAWKING, F., AND PERRY, W. L. M. 1948. Resistance to proguanil in a mammalian malaria parasite, *Plasmodium cynomolgi*. Lancet [London] 2(19):850.

HAWORTH, R. D., AND ROBINSON, S. 1948. Synthetic antimalarials. XXVii. Some derivatives of Phthalazine, Quinoxaline, and iso-Quinoline. [London] Chem. Soc. Jour. June: 777–782.

HEILBRON, I. 1948. The role of chemistry in combating tropical diseases. Nature [London] 161(4103):956–960.

HERING, E. R., PATT, H. M., AND LEAVITT, H. J. 1948. Tolerability studies of some new antimalarial drugs. Natl. Malaria Soc. Jour. 7 (4):322–329.

HOROWICZ, W. 1948. Henry's test in differential diagnosis of malaria. Polski tygod. lek. 3(17):521–525. (In Polish).

HSIAO, T. 1948. Epidemiology of the diseases of naval importance in Korea. U. S. Bur. Med. and Surg., Naved P–1289, 89 pp.

IRWIN, J. L., AND IRWIN, E. M. 1948. Apparent dissociation exponents of quinine, pamaquine, and a quinolylpiperidyl-carbinol; application of an extended pH scale. Jour. Biol. Chem. 174(2):577–587.

———— 1948. A fluorometric method for the determination of pamaquine, SN-13276, and SN-3294. Jour. Biol. Chem. 174(2):589–596.

JACKOWSKI, L. A. JR., AND SCHULTZ, C. 1948. Notes on the biology and control of mosquitoes at Umiat, Alaska. Mosquito News 8(4):155–165.

JAFAR, M., AND IYENGAR, M. O. T. 1947. The incidence of malaria in a deltaic area of Lower Bengal between the Damodar and the Hooghly Rivers. Indian Jour. Malariol. 1(4):441–467, 5 refs.

JENKINS, D. W. 1948. Ecological observations on the mosquitoes of central Alaska. Mosquito News 8(4):140–147.

JERACE, F. 1948. La malaria nell 'Agro Romano nel quinquennio 1943–1947. Riv. di Malariol. 27(2):103–110.

KENNY, M., AND HEWITT, R. 1949. Treatment of bancroftian filariasis with hetrazan in British Guiana. Amer. Jour. Trop. Med. 29(1): 89–114, 21 refs.

KERSHAW, W. E., WILLIAMSON, J., AND BERTRAM, D. S. 1949. Chemoprophylaxis of experimental filariasis in the cotton rat. Brit. Med. Jour. 4594:130–132, 15 refs.

KISSIN, M., AND ADLEMAN, R. J. 1948. Transient urticaria in malaria. Amer. Jour. Trop. Med. 28(6):797–801, 28 refs.

KNOPPERS, A. T. 1948. Acquired resistance against quinine in *Plasmodium gallinaceum*. Acta Brevia Neerland 16(1–4):34.

KOMP, W. H. W., AND BATES, M. 1948. Notes on the two mosquito gynandromorphs from Colombia. Ent. Soc. Wash. Proc. 50(8):204–206, 7 refs.

LAHIRI, S. C. 1947. Paludrine in malaria—clinical observations. Indian Med. Assoc. Jour. 17(2):27–32.

LAIRD, M. 1948. Reactions of mosquitoes to the aircraft environment. Roy. Soc. New Zeal. Trans. and Proc. 77(1):93–114, 26 refs.

LEWERT, R. M. 1948. Exoerythrocytic infection by *Plasmodium gallinaceum* in blood infected, quinone-treated chicks. Amer. Jour. Hyg. 48(2):158–170, 13 refs.

LEESON, H. S., AND THEODOR, O. 1948. Mosquitos of Socotra. Bul. Ent. Res. 39(2):221–229, 15 refs.

LICHTENSTEIN, E. P. 1948. Growth of *Culex molestus* under sterile conditions. Nature [London] 162 (4110):227.

LIMBOS, P. 1948. Presence de schizontes et de gametes de *Plasmodium falciparum*, dans le sang peripherique, 22 heures apres la naissance. Soc. Belge Med. de Trop. Ann. 28(2):269–271.

LINDUSKA, J. P., AND SURBER, E. W. 1948. Effects of DDT and other insecticides on fish and wildlife: Summary of investigations during 1947. U. S. Dept. Int. Cir. 15, 1–19.

LINDUSKA, J. P., AND MORTON, F. A. 1948. Tests of the permeability of fabrics to biting by mosquitoes. Jour. Econ. Ent. 41(5):788–794, 2 refs.

MACAN, T. T. 1948. Mosquitoes and malaria in the Kabaro and Kale Valleys, Burma. Bul. Ent. Res. 39(2):237–268, 10 refs.

MACDONALD, G. 1947. The policy of malaria prevention. Inst. de Med. Trop. An. 4:373–390, 12 refs.

———— 1947. The place of DDT as an anopheline larvicide. Inst. de Med. Trop. An. 4:391–411.

MACKERRAS, M. J., AND ERCOLE, Q. N. 1948. Observations on the development of human malarial parasites in the mosquito; factors influencing infection. Austral. Jour. Expt. Biol. 26(5): 449–458.

MAEGRAITH, B. G. 1948. Paludrine in the treatment and control of malaria. Inst. de Med. Trop. An. 4:413–426, 14 refs.

———— 1947. The syndrome of renal anoxia in malaria and backwater fever. Inst. de Med. Trop. An. 4:427–446, 33 refs.

MANFREDI, M. 1948. Prove di trattamento con paludrina (Farma 01015) nella malaria da vivax. Acta. Med. Ital. Mal. Infett. 3(8):295–208.

MANSON-BAHR, P. 1948. Milestones in malaria. Med. Times 76(11):463.

MANWELL, R. D. 1949. Malaria, birds and war. Amer. Scientist 37(1):60–68, 21 refs.

MCCARTHY, D. D., AND BAGSTER-WILSON, D. 1948. Dengue in the East African Command incidence in relation to *Aedes* prevalence and some

clinical features. Roy. Soc. Trop. Med. and Hyg. Trans. 42(1):83–88.

MCCAULEY, R. H., FAY, R. W., AND SIMMONS, S. W. 1948. The importance of coverage in DDT residual house spraying for control of *Anopheles quadrimaculatus* mosquitoes. U. S. Pub. Health Serv. Rpts. 63(13):401–407.

———— 1948. A comparison of the residual effectiveness of certain insecticides against *Anopheles quadrimaculatus*. Natl. Malaria Soc. Jour. 7(4):294–299, 5 refs.

MEIRA, M. T. V. DE, SIMOES, T. S., AND NOQUEIRA, J. F. 1947. Observations on malaria in the islands of Sal, Boa Vista, and S. Nicolau (Cape Verdes). Inst. de Med. Trop. An. 4:213–238, 15 refs.

MICKS, D. W., DE CAIRES, P. F., AND FRANCO, L. B. 1948. The relationship of exflagellation in avian plasmodia to pH and immunity in the mosquito. Amer. Jour. Hyg. 48(2):182–190, 16 refs.

MISSIROLI, A., MOSNA, E., AND ALESSANDRINI, M. 1948. La lotta antianofelica nell 'Agro Pontino; rapporto per gli anni 1945–1947. Rendic. Inst. Sup. San. [Rome] 11(3):759–790.

MONACI, V. 1947. L'esacerbazione dell'endemia malarica e l'anofelismo nel territorio di venezia. Riv. di Malariol. 26(4):191–211. [English Summary]

MORRISON, D. B., AND JESKEY, H. A. 1948. Alterations in some constituents of the monkey erythrocyte infected with *Plasmodium knowlesi* as related to pigment formation. Natl. Malaria Soc. Jour. 7(4):259–264, 7 refs.

MULHERN, T. D., AND HART, J. T., JR. 1948. A low cost, light weight excavator for digging or cleaning mosquito control ditches. Mosquito News 8(4):137–139.

MULHERN, T. D. 1948. New Jersey and New York Mosquito control executives witness demonstration of "jeep a trench" excavator. Mosquito News 8(4):166–167.

MULLICK, K. B., AND GUPTA, J. C. 1947. Intravenous paludrine in malaria. Indian Med. Gaz. 82(11):666–668.

NABOKOV, V. A., AND NIKIFOROVA, A. V. 1947. The application of DDT preparations in mosquito control. Med. Parasitol. and Parasitic Dis. 16 (1):10–16, 1 ref.

NELSON, R. H., AND COWORKERS. 1949. Low pressure aerosols—their efficiency in relation to formulation and particle size. Soap and Sanit. Chem. 25(1):120–121, 123, 125, 166, 5 refs.

NOYAN, A. 1948. Summary of the free lecture on malaria. Acta Med. Turc. 1(1):32–37.

OHTURU, M., OHBA, I., AND MIYAGAWA, M. 1948. Nipponsan *Anopheles hyrcanus* var. *sinensis* no issinkei ni tuite. Hukuoka Acta Med. 39 (1):104.

PAMPANA, E. J. 1948. Malaria control by residual indoor spraying with dichloro-diphenyl-trichloroethane (DDT). Survey of methods for testing residual toxicity and of results. World Health Organ. Bul. 1(2):253–296, 60 refs.

PARANJOTHY, J. T. 1947. Notes on some atebrin psychosis. Med. Jour. Malaya 2(1):49–51.

PEEL, E., AND VAN HOOF, L. 1948. Comportement de *Plasmodium falciparum* dans le derme chez l'enfant indigene. Soc. Belge de Med. Trop. Ann. 28(2):273–277.

PENN, G. H. 1948. Biological notes on "dry season" mosquitoes from Caminawit Point, Mindoro, P. I. Ent. Soc. Wash. Proc. 50(9): 241–248, 5 refs.

———— 1949. The pupae of the mosquitoes of New Guinea. Pacific Sci. 3(1):3–85.

PETTMAN, W. E. C. 1947. Flushing streams as an antimalaria measure under field service conditions. Indian Jour. Malariol. 1(4):395–412.

PINTO, A. R., AND ALMEIDA, C. L., DE. 1947. Contribution to the study of filariasis in Portuguese Guinea. Inst. de Med. Trop. An. 4:59–89, 14 refs.

PRATESI, F. 1948. La malaria con un lungo periodo di incubazione, osservazione clinica di 36 casi. Sperimentale 99(1–6):285.

PURI, I. M. 1948. The distribution of anopheline mosquitoes in India, Pakistan, Ceylon and Burma: Part V: additional records, 1936–1947. Indian Jour. Malariol. 2(1–2):67–107, 230 refs.

QUARTERMAN, K. D. 1948. Some factors influencing the residual effectiveness of DDT and chlordane in anopheline mosquito control. Natl. Malaria Soc. Jour. 7(4):300–306, 2 refs.

RACHOU, R. G., AND FERREIRA, M. O. 1947. As Kerteszias como os grandes responsaveis pela malaria no litoral do Estado de Santa Catarina. Folha Med. 28:1–3.

RAU, L. 1948. Malarial diabetes. Report of a case. Lancet [London] 2(1):11–12, 5 refs.

RAY, A. P. 1948. Prophylactic use of paludrine in a tea estate. Indian Jour. Malariol. 2(1–2):35–66.

RIGDON, R. H. 1948. Effect of blood and oxygen on *Plasmodium knowlesi* infection in monkeys. Amer. Jour. Hyg. 48(2):147–157, 11 refs.

ROBERTS, J. I. 1948. A comparison of haematological results in Europeans and Africans suffering from active malaria. Jour. Trop. Med. and Hyg. 51(11):228–234.

ROLLO, I. M., WILLIAMSON, J., AND LOURIE, E. M. 1948. Acquired paludrine resistance in *Plasmodium gallinaceum*. II. Failure to produce such resistance by prolonged treatment of latent infections. Ann. Trop. Med. and Parasitol. 42 (2):241–248, 19 refs.

ROTH, L. M. 1948. Mosquito gynandromorphs. Mosquito News 8(4):168–173, 19 refs.

———— 1948. A study of mosquito behavior. An experimental laboratory study of the sexual behavior of *Aedes aegypti* Linnaeus. Amer. Midland Nat. 40(2):265–352, 110 refs.

ROZEBOOM, L. E., AND KOMP, W. H. W. 1948. Three new species of *Culex* (Diptera: Culicidae) from Colombia. Jour. Parasitol. 34(5):396–406.

SANDICCHI, G. 1948. Relazione sugli esperimenti di terapia della malaria con il prodotto palusil. Riv. di Malariol. 27(2):123–129.

SARROUY, C., AND COWORKERS. 1947. A malignant attack of malaria in an infant of 3

months. Soc. Med. des Hop. Paris, Bul. et Mem. 61(7–8):115–117.

SCHNEIDER, J., AND MECHALI, D. 1948. Curative treatment of Malaria: Activity of four new synthetic derivatives compared. Soc. de Path. Exot. Bul. 41(3–4):274–282.

SCHROEDER, H. O., JONES, H. A., AND LINDQUIST, A. W. 1948. Certain compounds containing the methylenedioxyphenyl group as synergists for pyrethrum to control flies and mosquitoes. Jour. Econ. Ent. 41(6):890–894, 7 refs.

SCHWETZ, J., BAUMANN, H., AND FORT, M. 1947. Nouvelles recherches sur la repartition des *Anopheles* et du paludisme endemique au Congo Belge. I. Region du Lubilash-Sankuru. II. L'entre Kundelungu Kibara (Territoine de Sampwe, Province du Katanga.) Soc. Belge de Med. Trop. Ann. 27(3):289–321.

SENEVET, G. 1948. Nouvelles especes d'Anopheles. Inst. Pasteur d'Algerie, Arch. 26(2):149–161, 80 refs.

SENIOR-WHITE, R. 1948. Malaria transmission in the light of modern evolutionary theory applied to malaria-carrying mosquitoes. Indian Jour. Malariol. 2(1–2):13–33, 34 refs.

SEPULCRI, P. 1947. La campagna antimalarica con il DDT nel 1946 nelle provincie venete. Riv. di Malariol. 26(4):163–182.

SHORTT, H. E., AND GARNHAM, P. C. C. 1948. The pre-erythrocytic development of *Plasmodium cynomolgi* and *Plasmodium vivax*. Roy. Soc. Trop. Med. and Hyg. Trans. 41(6):713–716.

SHOUSHA, A. T. 1948. Species-eradication. The eradication of *Anopheles gambiae* from Upper Egypt 1942–1945. World Health Organ. Bul. 1(2):309–352, 3 refs.

SOPER, F. L. 1948. Saneamiento de especies aplicado ala erradicacion de (a) una especie invasora, O (b) indigena. Pan Amer. Union Bol. de la Ofic. Sanit. 27(7):603–610, 6 refs.

SPICKNALL, C. G., AND TERRY, L. I. 1948. Combined quinine-plasmochin and quinine pentaquine treatment of relapsing *vivax* malaria. South. Med. Jour. 41(4):338–341.

SPINKS, A. 1948. Studies on synthetic animalarial drugs. XX. The blood concentrations and physiological distribution of some homologues of paludrine in relation to their antimalarial activities. Ann. Trop. Med. and Parasitol. 42(2):190–197, 18 refs.

SPITLER, D. K. 1948. Malaria relapse of a case thirty-six years after original infection. New England Jour. Med. 238(24):839.

STAGE, H. H. 1948. References to literature of interest to mosquito control workers and malariologists. Mosquito News 8(4):204–210.

STRAHAN, J. H. 1947. Malaria in Sarawak. Med. Jour. Malaya 2(2):83–92.

STUDENY, O. 1948. Sanierung von malariaherden in Steiermark. Klin. Med. [Wien] 3 (18):768–778.

SWAROOP, S. 1949. Forecasting of epidemic malaria in the Punjab, India. Amer. Jour. Trop. Med. 29(1):1–17, 3 refs.

SWELLENGREBEL, N. H. AND SWELLENGREBEL, J. M. H. 1948. Malariabesmeeting in de opeenvolgende leeftijds klassen ever antochthone bevolking in hoog-endemische malariastreken der N-O-kust Van Nieuw-Guinea. Nederland. Tijdschr. V. Geneesk 92(42):3506–3511.

TALIAFERRO, W. H. 1948. The role of the spleen and the lymphoid-macrophage system in the quinine treatment of *gallinaceum* malaria, acquired immunity and phagocytosis. Jour. Infect. Dis. 83(2):164–180.

———— AND KELSEY, F. E. 1948. The role of the spleen and lymphoid-macrophage system in the quinine treatment of *gallinaceum* malaria; quinine blood levels. Jour. Infect. Dis. 83(2):181–199.

TERZIAN, L. A., AND STAHLER, N. 1948. The effects of larval population density on some laboratory characteristics of *Anopheles quadrimaculatus* Say. U. S. Nav. Med. Res. Inst. Proj. NM-005-019, Rpt.-1, 7 pp., 2 refs.

TERZIAN, L. A. AND WEATHERSBY, A. B. 1949. The action of antimalarial drugs in mosquitoes infected with *Plasmodium falciparum*. Amer. Jour. Trop. Med. 29(1):19–22, 3 refs.

THOMPSON, P. E. 1948. On the ability of *Plasmodium lophurae* to acquire resistance to chlorguanide, camoquin, and chloroquine. Jour. Infect. Dis. 83(3) 250–255.

TRAGER, W. 1948. The resistance of egg-laying ducks to infection by the malaria *Plasmodium lophurae*. Jour. Parasitol. 34(5):389–393.

———— 1948. Biotin and fat-soluble materials with biotin activity in the nutrition of mosquito larvae. Jour. Biol. Chem. 176(3):1211–1223.

TURNER, N., AND WOODRUFF, N. 1948. Toxicity of DDT residues. Conn. Agric. Expt. Sta. Bul. 524, 35 pp., 16 refs.

VAN DER KUYP, E. 1948. Mosquito records of Aruba and Bonaire. Amer. Jour. Trop. Med. 28(6):895–897, 5 refs.

VAN REIL, J., 1948. Evaluation of paludrine as a casual prophylactic and in the treatment of malignant tertian malaria. Soc. Belge de Med. Trop. Ann. 28(1):85–95.

VARGAS, L. 1948. Fototropismo positive en larvas de mosquito intoxicadas con DDT. Rev. Inst. Salubridad y Enferm. Trop. [Mexico] 9(1):47–49, 4 refs.

———— AND MATHESON, R. 1948. Estado actual del *Anopheles earlei* Vargas (1943) y *Anopheles occidentalis* Dyar & Knab (1906) con claves para larvas, pupas y adultos del llamado complejo *Maculipennis* de Norteamerica. Rev. Inst. Salubridad y Enferm. Trop. [Mexico] 9(1):27–33, 12 refs.

VENKAT-RAO, V., AND RAMAKRISHNA, V. 1947. Control of breeding of *A. sundaicus* by *Eichhornia*-cover. Indian Jour. Malariol. 1(4):419–421, 4 refs.

VEROLINI, F. 1948. Azione del DDT sull'epitelio intestinale di larvae di culicine. Riv. di Parassitol. 9(4):237–244, 6 refs.

VINE, M. J. 1947–1948. The antimalaria campaign in Greece. World Health Organization Bul. 1(1):197–204.

VISWANATHAN, D. K., AND RAMOCHANDRA RAO,

T. 1947. Control of rural malaria with DDT indoor residual spraying in Kanara and Dharwar Districts, Bombay Province. First year's results. Indian Jour. Malariol. 1(4):503–542, 12 refs.

VUILLET, J. AND LEVAVASSEUR, G. 1947. Biological stimulation of *Anopheles maculipennis* eggs by supersonic rays. Med. Trop. (Marseilles) 7(4):343–346.

WALKER, A. J. 1948. The teaching of malaria diagnosis. Amer. Jour. Trop. Med. 28(6):777–785. 29 refs.

WARTHIN, T. A., LEVINE, S. A. AND EVANS, R. R. 1948. Malaria Observations on treatment with chloroquine (SN 7618) and combined quinine and plasmochin. New England Jour. Med. 238(14):467–469.

WATSON, M. 1948. Sir Ronald Ross. Natl. Malaria Soc. Jour. 7(4):241–253.

WHITE, W. C., AND CO-WORKERS, 1948. Studies in human malaria. XXI. The cure of St. Elizabeth strain *vivax* malaria by pentaquine-quinine, administered during acute attacks or during latency. Natl. Malaria Soc. Jour. 7(4):316–321, 10 refs.

WILKINS, O. P., AND BRELAND, O. P. 1949. Recovery of the mosquito, *Culiseta inornata* (Williston) from dry material. Ent. Soc. Wash. Proc. 51(1):27–28, 4 refs.

WILLIAMSON, J. 1948. A monogram for the preparation of standard inocula in the Davey Chick Test of antimalaria activity. Ann. Trop. Med. and Parasitol. 42(2):238–240, 2 refs.

WILLIS, E. R., AND ROTH, L. M. 1949. A microscope stage for continuous anesthesia of insects. Science 109(2827):230, 1 ref.

WINCKEL, C. W. F. 1948. Le traitement du paludisme par la quinine. Rev. Paludisme et Med. Trop. 6(53):231–252.

WOLFF, J. W. 1948. Een eenvoudige snelle kleuring voor bloedonderzoek op malariaparasieten. Nederland. 92(37):2834–2837.

YACOB, K. B. M., AND SWAROOP, S. 1947. Malaria and spleen rate in the Punjab. Indian Jour. Malariol. 1(4):469–489, 4 refs.

———— 1947. Preliminary forecasts of the incidence of malaria in the Punjab. Indian Jour. Malariol. 1(4):491–501, 5 refs.

YOEMANS, A. H. 1948. Field-Model aerosol machines. U. S. Bur. Ent. and Plant Quar.. ET-258, 11 pp.

YOELI, M. 1948. Non-pigmented malaria parasites in the bone marrow from a mixed infection of *Leishmania* and *Plasmodium vivax*. Roy. Soc. Trop. Med. and Hyg. Trans. 42(1): 99–100, 1 ref.

LIST OF ADVERTISERS

	PAGE
John Bean Mfg. Co.	XI
California Spray Chemical Corp.	V
Clough Spraying Service	VIII
Essick Mfg. Co.	IV
Hardie Mfg. Co.	I
H. D. Hudson Mfg. Co.	XIV
Julius Hyman & Co.	VII
Insect Wire Screening Bureau	III
Lawrence Aero-Mist Sprayer Co.	II
F. E. Myers & Bro. Co.	VI
New Jersey Mosquito Extermination Comm.	XII
Rohm & Haas Corp.	X
Seacoast Laboratories, Inc.	IX
D. B. Smith & Co.	XIII
Southern Entomological Co.	VIII
Tidewater Willys, Inc.	XII
Todd Shipyards Corp.	V
Robert L. Vannote, Inc.	IX